

Instrument Serial Number



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## OSCILLOSCOPE TYPES D1010 & D1011

### INSTRUCTION MANUAL

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## INTRODUCTION

This Instruction Manual describes the Performance, Operation and Servicing of Oscilloscope Types D1010 and D1011. These are lightweight 10MHz a.c. mains powered, dual trace instruments, with a single time base and two identical vertical amplifiers. The scanning area is 8 x 10cm and has a time and voltage measurement accuracy of 5%.

The use of solid state circuitry incorporating integrated circuits and field-effect transistors minimises drift and provides fast stabilization time.

The facilities include a single trace display, or dual trace display with the two channels either chopped or alternated, and an external X mode.

Type D1011 has the additional facilities of (a) x5 gain on each channel (b) switching one channel for true X—Y display, (c) algebraic addition of two input signals, (d) variable control of sweep speeds between the marked positions of the SECS/DIV switch.

All references to the external operating controls are in capital letters e.g. BEAM FINDER.

The standards used throughout for symbols and unit abbreviations are IEC27 and BS1991.

## SAFETY IN OPERATION

To enable the user to operate an instrument in the proper manner and with complete safety, it is essential that the following cautionary notices are understood and strictly observed.

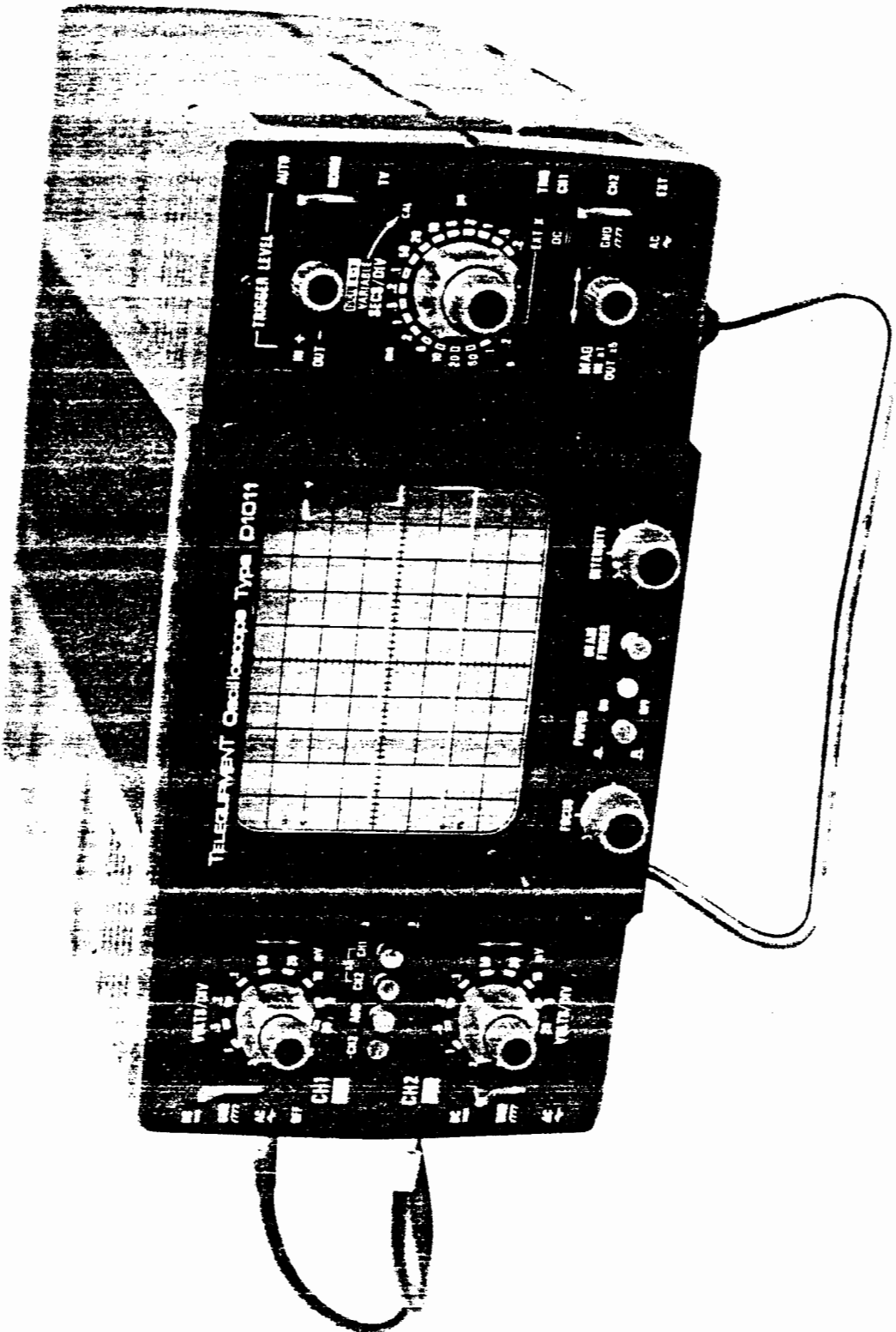
- 1) For safety purposes a protective-ground (earth) connection by way of the power cord and plug is essential.
- 2) The CRT circuitry contains high voltage and therefore presents an electric shock hazard when the covers are removed.
- 3) It is imperative that only **qualified** persons should attempt any servicing or calibration which necessitates removal of the covers.
- 4) Always consult TEKTRONIX if in doubt on any aspect of the instruments.

From time to time, changes to the instruments could be incorporated, due to the policy of continual development and improvement. These changes which usually affect the Parts List and Diagrams are described on Amendment Lists issued between manual reprints. Any Amendment List appertaining to this Manual is located in the pocket inside the back cover.

## NOTICE TO OWNER

If an instrument is to be returned to a Service Centre, please do not send loose items such as accessories unless they are suspected of being faulty. This will lessen the risk of damage during transit and also facilitate packing.

Please quote the instrument type number and serial number in any correspondence.



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# SECTION 1

## SPECIFICATION

### 1.1 CATHODE RAY TUBE (CRT)

	Rectangular flat faced CRT.
Display area	10 × 8 divisions (each division = 1.0cm)
Phosphor	P31
Overall accelerating potential	1.8kV
Z Modulation	15V amplitude, d.c. coupled.

### 1.2 VERTICAL AMPLIFIERS

#### 1.2.1 OPERATING MODES

CH2
CH1 and CH2 alternate from 1ms/div to 0.2 $\mu$ s/div.
CH1 and CH2 chopped from 0.2s/div to 2ms/div.
Chop or alternate selected automatically on SECS/DIV switch.
Add and subtract CH1 and CH2 algebraically. (D1011 only).
X-Y (D1011 only) Bandwidth is DC to 2MHz (-3db).
Phase error is <3° at 100kHz.

#### 1.2.2 BANDWIDTH (-3db)

DC coupled	DC — 10MHz
AC coupled	8Hz — 10MHz
Risetime	35ns (approx)

#### 1.2.3 VERTICAL DEFLECTION

Calibrated (12 steps 1,2,5 sequence)	5mV/div to 20V/div $\pm$ 5%
Input impedance	1M $\Omega$ in parallel with 45pF approx.
Maximum Input Voltage	500V peak a.c. or d.c.
Maximum Scan	Amplitude 8 divs (6 divs at 10MHz)
x5 Gain Sensitivity (D1011 only)	1mV/div (bandwidth DC to 4MHz (-3db))

### 1.3 HORIZONTAL DEFLECTION

#### 1.3.1 SWEEP SPEEDS (19 steps in 1,2,5 sequence)

Normal	0.2s/div to 0.2 $\mu$ s/div $\pm$ 5%
x5 Gain	Maximum speeds of 40ns/div $\pm$ 7%

On D1011 only a variable uncalibrated control provides continuous coverage between steps extending the slowest speed to 0.5s/div.

#### 1.3.2 TRIGGER

Normal	Fully operational from 10Hz to 15MHz
	Level control will select any point on the waveform $\pm$ 4 divs about the mean d.c. level of the signal.

Automatic trigger on all repetitive waveforms >0.5 div and with mark space ratio <500 : 1. The level control will select any point on the waveform between 10% and 90% (approx) of the peak to peak value.

TV	TV field for sweep ranges 0.2s/div to 100 $\mu$ s/div and TV line from 50 $\mu$ s/div. to 0.2 $\mu$ s/div. (Level control inoperative).
Source	Internal. CH1 CH2 External All positive or negative.
Internal Sensitivity	0.5 div
External Sensitivity	0.5V

**1.3.3 EXTERNAL X**

Bandwidth	
DC coupled	DC to 2MHz (-3db)
AC coupled	10Hz to 2MHz (-3db)
Sensitivity	1V/div approx.
Input Impedance	280k $\Omega$ in parallel with 30pF approx.

**1.4 CAL OUTPUT SOCKET**

Output Voltage	250mV $\pm$ 2% peak to peak
Frequency	At sweep repetition rate
Wave Shape	Vertical step at screen centre

**1.5 GENERAL****1.5.1 POWER REQUIREMENTS**

Mains	
Voltage	100V to 125V or 200V to 250V
Frequency	48Hz to 440Hz
Consumption	50VA approx.

**1.5.2 SIZE**

Height (stand retracted)	160mm
Width	300mm
Depth	420mm

**1.5.3 WEIGHT**

8kg

**1.5.4 COOLING**

Convection combined with Heatsink mounting.

**1.5.5 TEMPERATURE RANGE (AMBIENT)**

Operational	0 $^{\circ}$ C to 40 $^{\circ}$ C
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# SECTION 2

## OPERATION

### 2.1 GENERAL

This section describes the various mechanical features and the purposes of the Control and Connection points, to enable the user to get full benefit from the facilities provided by the instrument.

### 2.2 MECHANICAL FEATURES

The instrument has been designed for general use but its lightweight construction makes it comparatively easy to handle and to carry.

#### 2.2.1 HANDLE

This is hinged at both sides of the CRT bezel and folds back on top of the bezel when not in use.

#### 2.2.2 TILT STAND

To position the instrument on the bench at a convenient viewing angle, a tilt stand is hinged on the underside of the case and folds flat when not in use.

#### 2.2.3 FEET

To enable the instrument to stand firmly in two attitudes, feet are fitted on the underside and on the rear end.

#### 2.2.4 CABLE STOWAGE

On the underside of the case four lugs are arranged as a wrap-around cable stowage with a clip to retain the end of the cable.

#### 2.2.5 COOLING SYSTEM

Whilst in operation a number of the components inside the case generate heat which has to be dispersed quickly. The method used is for the 'hot' components to be mounted adjacent to and on a large heatsink that also acts as a rear panel and as long as the free air surrounding the instrument does not exceed 40°C, there will be no danger from overheating. As an additional safeguard, ventilation slots are moulded into the top and bottom of the case and rely on conventional convection cooling. These slots should never be covered so that the airflow is impeded whilst the instrument is in operation.

### 2.3 CONTROLS AND CONNECTION SOCKETS

The external controls and connectors are grouped according to their function; the majority of the controls appear on the front panels around the CRT display area.

The following descriptions define briefly their functions and also their locations.

#### 2.3.1 CRT CONTROLS

(on centre front panel)

FOCUS	Rotary control for display definition.
POWER	Push/push switch for the instrument mains supply ON/OFF control.
BEAM FINDER	Push and hold control to bring the trace into the display area whilst adjusting the POSITION controls.
INTENSITY	Rotary control to vary the brightness of the display.

#### 2.3.2 VERTICAL AMPLIFIERS CONTROLS

(on left front panel)

VOLTS/DIV CHANNELS 1 & 2	Rotary switch to select from a range of 12 values of attenuation for the input signal, calibrated in volts per division on the vertical (Y) axis. The white line on the knob indicates the setting position.
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DC-GND-AC-OFF  
CHANNEL 1

Lever switch selects a suitable coupling for the input signal. a) In the DC position the signal is connected directly to the attenuator. b) In the GND position the input signal is disconnected and the input from the attenuator is grounded. This provides a zero d.c. level for reference purposes. c) In the AC position the signal is connected via a capacitor to the attenuator. d) In the OFF position, CH1 is isolated to allow the single trace of CH2 to be displayed.

DC-GND-AC  
CHANNEL 2

Similar to CH1 except for the omission of the OFF position.

—CH2  
(D1011 only)

Push/push switch. The IN position inverts the polarity of the CH2 signal.

ADD  
(D1011 only)

Push/push switch. The IN position adds both input signals together algebraically and the resultant sum is displayed. With —CH2 depressed the display is the algebraic difference between the signals. The OUT position cancels the addition or difference.

x5  
(CH2 & CH1)  
(D1011 only)

Push/push switch. The IN position increases the sensitivity of the VOLTS/DIV settings by 5 times the marked values. e.g. 5mV becomes 1mV.

#### Note 1

The maximum signal (a.c. and/or d.c.) that can be accommodated without distortion or interaction between channels is less than  $\pm 8$  divisions from the screen centre. This also applies when the trace is positioned off the screen by the vertical position control.

Rotary control (concentric with the VOLTS/DIV switch knob) raises or lowers the display on the vertical (Y) axis. In the X-Y Mode CH1 position  $\updownarrow$  becomes the horizontal position control.

#### Note 2

The vertical position controls can balance out a d.c. component in the displayed waveform provided that the limitation of Note 1 above is observed.

#### 2.3.3 TIMEBASE CONTROLS

(on right front panel)

SECS/DIV

Rotary switch to select from a range of 19 values of sweep speed calibrated in seconds per division on the horizontal (X) axis. The white line on the knob indicates the setting position.

Sweep speeds are as indicated by the panel markings only when a) The  $\leftrightarrow$  position control is pushed in for x1 gain. b) VARIABLE (D1011) control is set to the CAL position and pushed in (D1011).

The extreme anticlockwise position is for EXT X mode to allow the input of an external X signal.

CHOP mode is selected from the range of speeds 0.2secs/div to 2ms/div; ALTERNATE mode is selected from the range of speeds 1ms/div to 0.2µs/div.

VARIABLE  
(D1011 only)

Rotary control, (concentric with SECS/DIV switch) when pushed in enables sweep speeds to be selected between the setting of the SECS/DIV switch and the adjacent slower position. When pulled out, the control sets the trace for the X-Y mode and overrides all other modes.



Rotary control moves the display to the left (anticlockwise) or right (clockwise) on the horizontal (X) axis. It combines with a push/pull switch to set x1 gain when pushed in and x5 when pulled out.

In the X-Y mode the control has no purpose.

TRIGGER LEVEL

Rotary control to select the point on the signal waveform at which the sweep is triggered. It combines with a push/pull switch to change the polarity of the waveform. Push for positive (+) pull for negative (-).

AUTO-NORM-TV

Lever switch is part of the triggering function. In the AUTO position, a stable display for almost any waveform is produced. The LEVEL control will give a small amount of horizontal adjustment. If a signal has insufficient amplitude or pulse repetition rate, a free running reference trace will appear.

In the NORM position, LEVEL control can be adjusted for triggering from any part of the leading edge of the displayed signal.

When TV is selected the trigger circuit acts as a sync separator to give field and line sync for TV frequency comparisons. The LEVEL control is inoperative in this mode.

DC-GND-AC  
or  
CH1-CH2-EXT

Lever switch with a dual purpose. In the EXT X mode, DC-GND-AC apply and provide selection of a suitable signal coupling.

In the TRIG mode CH1-CH2-EXT apply and provide a choice of triggering signal source when using a sweep speed.

2.3.4 REAR PANEL CONTROLS  
ASTIG

Rotary control operated by a screwdriver and used in conjunction with the FOCUS control to obtain the best overall display definition.

TRACE ROTATE

Rotary control to align the trace with the lines on the CRT graticule.

2.3.5 CONNECTION SOCKETS

(on left side)

CH1 INPUT

BNC connection for input signals to Channel 1 vertical amplifier.

CH2 INPUT

BNC connection for input signals to Channel 2 vertical amplifier.



4mm socket with direct connection to earth.

(on right side)

CAL 0.25V p-p

4mm connection provides a waveform signal for checking the calibration of the vertical channels.

(PROBE ADJUST  
use 1ms/div)

When checking probes set the SECS/DIV switch between 0.5msecs/div and 2msecs/div.

TRIG OR EXT  
INPUT



(on left rear)  
Z INPUT

BNC connection for either an external triggering signal, or an external input to the horizontal amplifier.

4mm socket with direct connection to the instrument earth.

BNC socket for an input signal to blank the trace.  
Level: +5V to 20Vpk.

2.4 CRT GRATICULE

The graticule is a blue tinted sheet of transparent material with high stability that is placed in front of the CRT faceplate. It is marked with eight vertical divisions and ten horizontal divisions.

Each major division on the Vertical and Horizontal centre lines is marked into five sub divisions.

2.5 OPERATING VOLTAGE

The instrument will operate from a line voltage source of either 100 to 125 a.c. volts or 200 to 250 a.c. volts with a frequency range of 48 to 440Hz.

To prepare the instrument for first time use or when changing to the alternative line voltage, the following procedure should be strictly observed.

1. Determine the line voltage level from which the instrument will operate.
2. Ensure that the instrument is not connected to a voltage source.
3. The Voltage Selection switches are visible through a window on the underside of the bottom cover.
4. Observe the setting of the range switch 234V — 117V.
5. If a change of range setting is necessary, lift off the top cover after loosening the four screws, then remove the bottom cover after loosening the four screws located through the feet.
6. Select the voltage range.
7. Set the voltage adjustment switch so that the supply voltage lies within the stated range.  
In the case of a supply voltage between 110 to 112V or 220V to 225V, the higher voltage range should be used.
8. Remove the flexible marked panel and change the fuse to suit the voltage ranges as follows:—  
234V requires a 'slow blow' 400mA x 20mm fuse  
117V requires a 'slow blow' 800mA x 20mm fuse
9. Re-fit the flexible panel.
10. Re-fit the bottom and top covers and secure with screws.
11. To alter the setting of the voltage adjustment switch, an access hole in the transparent window allows the use of a small screwdriver to move the switch.

2.6 POWER CORD

The three core power cord is wired in and leaves the instrument from the rear panel.

If the instrument is for use on the American continent a suitable three pin plug is fitted, otherwise three short tails are left for different types of connection.

Colour Code

The three cores of the power cord are colour coded as follows:—

- LINE ..... Brown
- NEUTRAL ..... Blue
- SAFETY EARTH (Ground) ..... Green/Yellow

For safety reasons it is important that the earth wire is connected and if an extension lead is used it is essential that there is earth continuity.

2.7 FIRST TIME OPERATION

The following procedure will enable the user to become familiar with the instrument controls before attempting the more advanced techniques as described in Applications Section 3.

The warm-up time after switch-on is approximately 5 minutes, however more time should be allowed when the instrument is being used for the first time after removal from its packing or it has been in a cold atmosphere for any length of time.



## 2.8 SETTING THE CONTROLS

POWER	Off
INTENSITY	Central
FOCUS	Central
CH1 (VOLTS/DIV (DC-GND-AC- OFF	0.5V OFF
CH2 (VOLTS/DIV (DC-GND-AC	0.5V DC
CH1 ( $\updownarrow$ CH2 ( $\updownarrow$	Central
- CH2 ADD x5 (CH1 & CH2) (D1011 only)	All buttons out
SECS./DIV	0.2ms
TRIGGER LEVEL	Central
+ -	+
AUTO-LEVEL-TV	AUTO
SECS./DIV VARIABLE (D1011 only)	In and fully clockwise
$\leftrightarrow$	In and central
CH1-CH2-EXT	CH2

## 2.9 SWITCH-ON

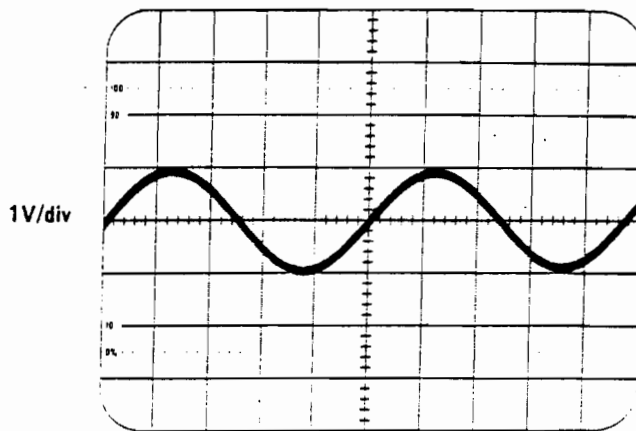
1. Ensure that the voltage selection settings are correct.
2. Push in the POWER ON/OFF switch.
3. Allow sufficient time for the display to appear on the screen.
4. If the display does not appear, press the BEAM FINDER switch and hold to bring the display into the screen area. If no trace, increase intensity.
5. Centralize the display with the  $\leftrightarrow$  and  $\updownarrow$  controls then release the BEAM FINDER switch.
6. Adjust the INTENSITY control until the display brightness is at a suitable viewing level.
7. Adjust the FOCUS control for the best overall definition.
8. Adjust CH2  $\updownarrow$  control to bring the lower edge of the display level with the centre graticule line.
9. Align the trace with the horizontal graticule lines using the TRACE ROTATE control on the rear panel.
10. Connect a 1kHz input signal of 1V (approx) to the CH2 input socket.
11. The display should have a height of 2 divisions (see fig. 2.1).
12. Switch CH2 VOLTS/DIV to 1 volt/div.
13. The display should now have a height of 1 div (see fig. 2.2).
14. Turn the SECS/DIV anticlockwise step by step and notice that the sweep speed decreases.
15. Set the SECS/DIV switch to 0.2ms and observe the display. (See fig. 2.1).
16. Set the SECS/DIV switch to 0.5ms and compare the waveform shape with that of the previous setting in step 15. (See fig. 2.3).
17. Pull out x5 switch and note that the sweep speed is now 5 times faster than the marked setting of 1ms. The actual speed will be 0.2ms.

The user should now be familiar with the operation of the basic controls. The remaining controls for the more advanced facilities provided by this instrument are now described.

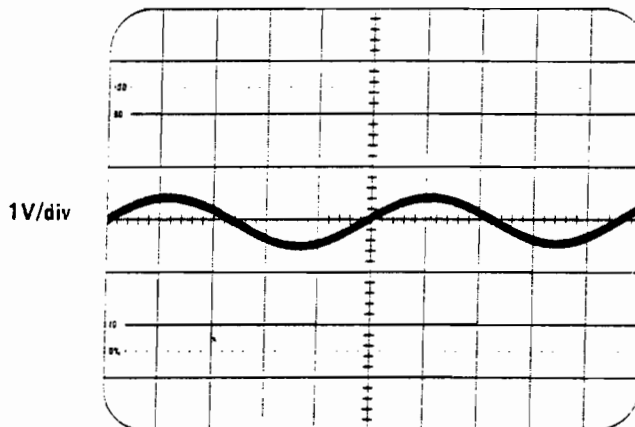
## 2.10 INPUT SIGNAL COUPLING DC-GND-AC

The switch selects the most suitable coupling for the incoming signal.

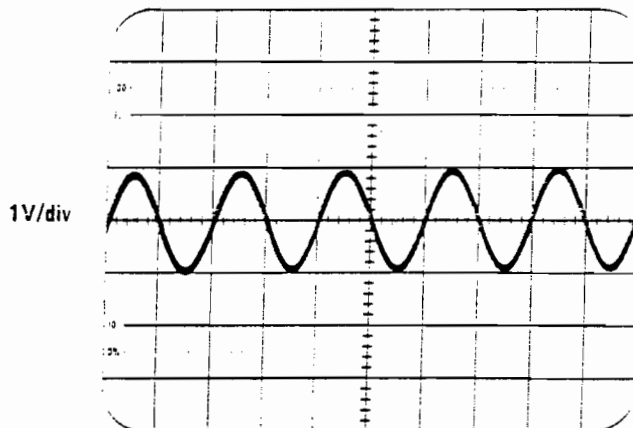
The DC position provides direct connection to the vertical amplifier for all frequency components of an input signal. The AC position suppresses with a capacitor the d.c. and low frequency components of a signal so that the a.c. components are displayed.



0.2ms/div  
Fig. 2.1



0.2ms/div  
Fig. 2.2



0.5ms/div  
Fig. 2.3

The Input Time Constant is 22ms (0.22s with 10M $\Omega$  probe).  
The GND position earths the attenuator input so that the zero volt d.c. level can be determined.

## 2.16 EXT X

In this mode any signal applied to EXT X appears on the X axis when the SECS/DIV switch is set fully anti-clockwise to the EXT X position. The lever switch selects the coupling DC-GND-AC.

## 2.11 TRIGGERING

This is the action of synchronising the starting point of the horizontal deflection of the timebase with the input signal waveform.

## 2.12 TRIGGER MODES

There are three modes (methods) of triggering, namely AUTO-NORM-TV.

- 2.12.1 In the AUTO mode triggering will occur on almost any type of waveform with voltage LEVEL selection over most of the positive or negative going edge.  
In the absence of a triggering signal a free running bright line trace will appear which can be used as a reference.
- 2.12.2 The NORM mode gives the LEVEL control a variable trigger point setting in selecting the triggering position especially on complex waveforms and lower frequency signals.
- 2.12.3 In TV mode triggering will occur on field and line sync pulses of TV signal waveforms. This is achieved by setting the SECS/DIV switch from 0.2secs/div to 100 $\mu$ s/div for field, and 50 $\mu$ s/div to 0.2 $\mu$ s for line.  
The polarity + or - should be set to coincide with the polarity of the TV waveform. The LEVEL control is inoperative in the TV position.

## 2.13 TRIGGER SOURCE

A choice of three waveform sources is available by setting of lever switch CH1-CH2-EXT.

- 2.13.1 The CH1 and CH2 positions allow the sweeps to be triggered internally and are suitable for most applications. The trigger signals are derived from the vertical amplifiers.
- 2.13.2 The EXT position allows a signal from an outside source to trigger the sweep.

## 2.14 X-Y DISPLAY (D1011 only)

This facility allows two input signals of the same frequency up to 100kHz to be examined for phase difference measurement by a display of Lissajous figures.

In this mode one signal is fed into CH1 input for the horizontal deflection and the other signal is fed into CH2 input for the vertical deflection.

## 2.15 CHOP and ALTERNATE Modes

Although the CRT is a single beam type the instrument is designed to display two traces. This is achieved by sharing the display time between the two signals.

- 2.15.1 In the CHOP mode the CRT beam switches between the two traces and displays a part of each waveform in turn at the lower sweep speeds of 0.2s/div to 2ms/div.
- 2.15.2 The ALTERNATE mode is more suitable for the faster sweep speeds of 1ms/div to 0.2 $\mu$ s/div and the full waveform is displayed in turn.

# SECTION 3 APPLICATIONS

## 3.1 GENERAL

- 3.1.1 These instruments are for general purpose use and have been designed to provide facilities for a wide range of applications.
- 3.1.2 One of the commonest uses for an oscilloscope is the display of repetitive waveforms. By suitable adjustment of the controls it is possible to look at a fraction of one cycle or a number of cycles.
- 3.1.3 The dual channel facility provided by the D1010 and D1011 oscilloscopes enable two waveforms to be displayed simultaneously for comparison.
- 3.1.4 There are two ways of connecting a signal to an oscilloscope. The first is by direct connection of a screened cable with correct impedance matching and the second way is by means of a high impedance probe connected via a screened cable.
- 3.1.5 Probes can have inbuilt attenuation and can be selected to suit the size of the signal voltage. The attenuation factors can be from 1:1 to 100:1 for very small signals to large signals. The most commonly used probe has an attenuation factor of 10:1, and has an input resistance of 10MΩ when connected to the oscilloscope.

## 3.2 PROBE ADJUSTMENT

Before using a x10 or x100 probe it is advisable to check the setting for the best definition. The following procedure is suitable for a 10:1 probe:—

1. Set the SECS/DIV switch to 1ms/div.
2. Connect probe connector to the CH2 input and the probe tip to the CAL socket centre with earth clip connected to the ground socket.
3. Set Trig source to EXT.
4. Set VOLTS/DIV switch to 0.1V.
5. On D1011 only set variable SECS/DIV control to CAL.
6. The display should be a step response.
7. Adjust the probe trimmer for best obtainable square +ve corner.

## 3.3 PEAK TO PEAK VOLTAGE MEASUREMENT

AC — Symmetrical waveform

1. Connect the waveform to be measured to the CH2 input.
2. Set the VOLTS/DIV switch to display about 5 or 6 divisions of the waveform.
3. Set the DC-GND-AC switch to AC.
4. Set the SECS/DIV switch to display several cycles of the waveform.
5. Use the  $\updownarrow$  position control to set the lower edge of the waveform on one of the lower graticule lines so that the top edge of the waveform is in the graticule area.
6. Measure the vertical amplitude (div) of the signal on the screen.
7. Multiply the amplitude in step 6 by the VOLTS/DIV setting and by the attenuation factor of any probe used.

### EXAMPLE

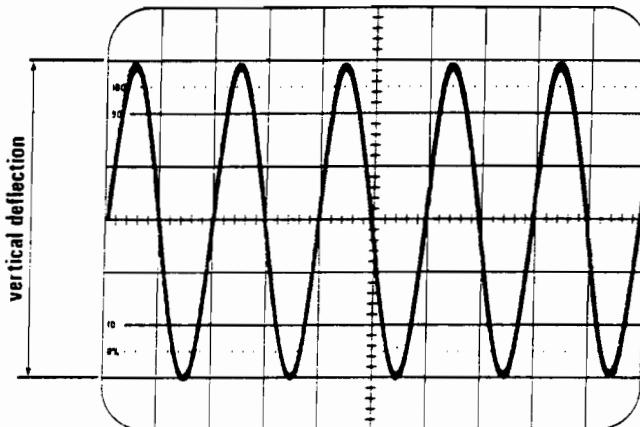
Assume a vertical deflection of 5.3 divisions using a x10 attenuation probe and a VOLTS/DIV setting of 0.05 volts per division.

∴ Peak to Peak Voltage =

$$\text{Vertical Deflection} \times \text{VOLTS/DIV (Setting)} \times \text{Attenuator Factor (probe)}$$

for the example

$$\text{Peak to Peak voltage} = 5.9 \times 0.05 \times 10 = 2.95 \text{ volts}$$



## 3.4 VOLTAGE MEASUREMENT BETWEEN TWO POINTS ON A WAVEFORM

Proceed as in 3.3 substituting the two measurement points for the peaks and setting the lower point on one of the lower graticule lines.

## 3.5 INSTANTANEOUS VOLTAGE MEASUREMENT WITH REFERENCE TO GROUND

To make a measurement of the DC level at a specified point on a waveform use the following procedure.

1. Set the DC-GND-AC switch to GND.
2. Use the  $\updownarrow$  position control to centre the trace.
3. Set the DC-GND-AC switch to DC.
4. Set the CH1-CH2-EXT to CH2
5. Set the TRIG LEVEL control to the AUTO position.
6. Connect the waveform to be measured to the CH2 input.
7. Establish the polarity of the measured voltage. If the measurement point is above the centre line the voltage is positive. If the measurement point is under the centre line it is negative.
8. If the waveform is repetitive use the SECS/DIV and  $\rightarrow$  controls to display at least one cycle.
9. Set the DC-GND-AC switch to GND.
10. Set the trace to the lowest graticule line or other suitable reference line, using the  $\updownarrow$  position control, if the point to be measured is positive. Set to highest or other suitable graticule line if the point to be measured is negative. AFTER THIS DO NOT ADJUST THE  $\updownarrow$  POSITION CONTROL.
11. Set the DC-GND-AC switch to DC.
12. Measure the distance in divisions from the reference line to the point to be measured.
13. Multiply the measurement in step 12 by the VOLTS/DIV switch setting and any probe attenuation factor.

### EXAMPLE

Assume that the vertical distance measured is +2.7 divisions with a VOLTS/DIV setting of 200mV and the probe attenuation factor is x1

∴ Instantaneous voltage =

$$\text{Vertical distance (divisions)} \times \text{Polarity} \times \text{VOLTS/DIV (Setting)} \times \text{Probe Attenuator factor}$$

For the values given

$$\text{Instantaneous voltage} = 2.7 \times 1 \times 0.2 \times 1 = 0.54 \text{ volts}$$

### 3.6 INSTANTANEOUS VOLTAGE MEASUREMENT WITH REFERENCE TO A DC VOLTAGE

Proceed as in 3.5 but in step 9 set the input switch to DC and feed in the reference voltage to the input. Step 11a will be to remove the reference voltage, and re-connect the waveform.

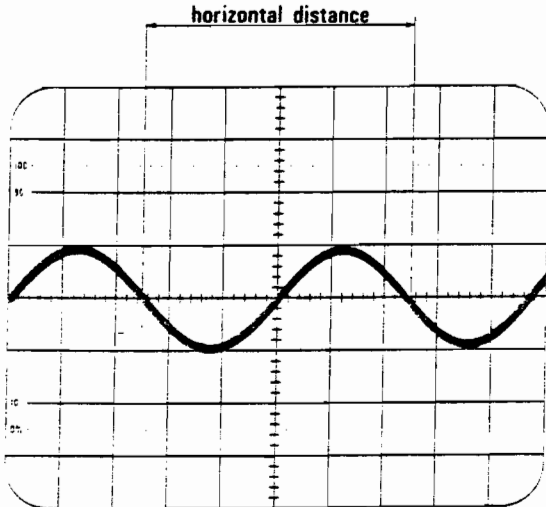
*Note:*  
The oscilloscope can be used as in paragraphs 3.3, 3.4, 3.5 and 3.6 to resolve an a.c. waveform with d.c. level. The latter is established first at some reference point on the a.c. waveform and the a.c. component can then be measured more accurately by expanding the signal with the switch set to AC.

### 3.7 TIME DURATION MEASUREMENT

1. Connect the waveform to be measured.
2. Set the VOLTS/DIV switch to display a suitable vertical amplitude of the waveform.
3. Set the SECS/DIV and LEVEL controls to display the appropriate portion of the waveform to measured over the maximum number of horizontal graticule divisions possible, keeping well inside the graticule limits.
4. Use the  $\updownarrow$  position control to move the trace so that the measurement points are on the horizontal centre line.
5. The  $\leftrightarrow$  position control is used to move the start of the measurement period to a convenient reference point.
6. If fitted, ensure VARIABLE control is fully clockwise.
7. Measure the distance (divs) between the measurement points.
8. Multiply the measurement is step 7 by the setting of the SECS/DIV switch.

**EXAMPLE**  
If the distance between the points is 5 divisions with the SECS/DIV control on 0.2ms/div.

$$\begin{aligned} \text{Time duration} &= \text{horizontal distance (divisions)} \times \text{SECS/DIV setting} \\ &= 5 \times 0.2\text{ms} \\ &= 1.0\text{ms} \end{aligned}$$



### 3.8 FREQUENCY MEASUREMENT

The time duration technique shown in 3.7 can be used to establish the frequency of a periodically recurrent waveform. The start of two adjacent cycles is taken as the measurement points and the time duration between these points established. The frequency is the reciprocal of the time duration.

**EXAMPLE**  
If one cycle occupies 5 divisions with the SECS/DIV switch on 0.2ms/div

$$\text{Time Duration} = \text{Horizontal distance (divs)} \times \text{SECS/DIV (setting)}$$

for the example

$$\begin{aligned} \text{Time duration} &= 5 \times 0.2\text{ms} \\ &= 1.0\text{ms} \\ \text{Frequency} &= \frac{1}{\text{Time duration}} \\ &= \frac{1}{1.0 \times 10^{-3}} \\ &= 1\text{kHz} \end{aligned}$$

*Note:*  
During Time or Frequency measurements, resolution can be enhanced if the signal is displayed over at least 6 divisions vertically, but not more than  $\pm 2$  divisions vertically off screen.

### 3.9 RISE AND FALL TIME MEASUREMENTS

Rise time measurements employ the same basic techniques as time duration measurements. Rise time  $t_r$  is the time required by the leading edge of a waveform to rise from 10% to 90% of the waveform amplitude. The procedure is as follows:—

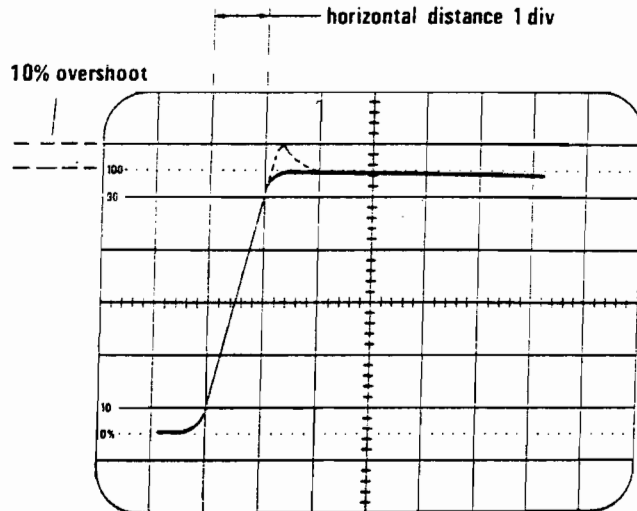
1. Connect the waveform to either input.
2. Set the DC-GND-AC switch to AC.
3. Set the VOLTS/DIV switch to display 4 to 8 divisions amplitude.
4. Centre the display about the centre horizontal line.
5. Set the trigger controls to obtain a stable display.
6. Set the SECS/DIV switch so that the 10% and 90% points of the waveform lie within the centre 8 divisions horizontally.
7. Determine the 10% point of the waveform and use the  $\leftrightarrow$  and  $\updownarrow$  position controls to set this point to a convenient graticule point.
8. Determine the 90% point and estimate the horizontal distance in graticule divisions between the 10% and 90% points of the waveform.
9. Multiply the distance obtained in step 8 by the setting of the time divisions switch. If the result is close to the rise time of the instrument it is necessary to apply a correction factor (See 3.10).
10. Fall time is the time required by the trailing edge of a waveform to fall from 90% to 10% of a waveform amplitude. The procedure is similar to steps 1 to 9.

**EXAMPLE**  
Assume that the horizontal distance between the 10% and 90% points is 5 divisions and the SECS/DIV switch is set to 20ms.

$$\text{Rise time} = \text{horizontal distance (divs)} \times \text{SECS/DIV setting}$$

for the example

$$\begin{aligned} \text{Rise time} &= 1 \times 20\text{ms} \\ &= 20\text{ms} \end{aligned}$$



### 3.10 CORRECTION FORMULA FOR FAST RISE TIME WAVE FORMS

When the rise time of the oscilloscope is of the same order as the rise time of the waveform being measured it is necessary to apply a correction formula as follows:—

$$\text{Actual Rise time (tra)} = \sqrt{\left(\text{Measured Rise time (trm)}\right)^2 - \left(\text{Oscilloscope Rise time (tro)}\right)^2}$$

#### EXAMPLE

Assume the rise time found by the method given in 3.9 is 60ns. The oscilloscope rise time is approximately 35ns applying

$$\begin{aligned} \text{Actual rise time} &= \sqrt{60^2 - 35^2} \\ &= \sqrt{3600 - 1225} \\ &= \sqrt{2375} \\ &= 48.7 \text{ ns} \end{aligned}$$

NOTE It should not be necessary to apply the correction to waveforms having a rise time greater than 300ns. Also the quoted rise time is the maximum figure and the actual rise time could be considerably better than this. This would mean that a calculated rise time would be in error. If it is necessary to work to great accuracy it would be necessary to measure the bandwidth of the instrument and calculate the rise time as follows:

$$\text{Rise time} = \frac{350}{\text{Bandwidth (MHz)}} \text{ ns}$$

### 3.11 PHASE DIFFERENCE MEASUREMENT

The following method is for the measurement of phase difference between two sinewave signals when there is no X-Y facility or for signals above 100kHz.

1. Connect one signal to CH1 input.
2. Connect the other signal to CH2 input.
3. Set both DC-GND-AC switches to DC.
4. Set Trigger Level switch to AUTO.
5. Set Trigger source switch to CH2.
6. Adjust controls for maximum height of display and equal disposition about the horizontal centre line.
7. Adjust the LEVEL control so that a selected point on one waveform lies on the horizontal centre line.
8. Adjust SECS/DIV switch until the half cycles of the waveforms measure 4 divisions on the horizontal centre line.
9. Each division  $\frac{180^\circ}{4 \text{ divs}} = 45^\circ$
10. Measure the distance in divisions between the corresponding points on each waveform on the horizontal centre line and multiply by the degrees per division.

# SECTION 4

## CIRCUIT DATA

### 4.1 INTRODUCTION

This section contains the description of the circuitry — list of electrical components with characteristics and circuit references — circuit diagrams and waveforms.

The data is arranged as six sub-circuits each of which deals with a major part of the instrument.

Each sub-circuit contains its own circuit description, list of electrical components in circuit reference order, circuit diagram and waveforms. Where possible, the data has been arranged across adjacent fold-out pages to make it easier for cross referencing.

Each circuit diagram has a reference number, for example (Diagram 4) is the Vertical Output Amplifier. To minimise the risk of misinterpretation of component values on diagrams and lists, the decimal point has been replaced by the multiplier or sub-multiplier of the standard unit. For example, a resistor of 2.2 megohms is shown as 2M2; similarly, a capacitor of 1.8 picofarads is shown as 1p8.

Each circuit diagram includes a component reference table to assist in locating a particular component on the diagram. Component references are divided into blocks of numbers appropriate to each major sub-circuit.

The blocks are shown on the following table:—

Circuit	Reference	Circuit Diagram	No.
From	To		
1	60	Trigger Amplifier	5
61	100	Sweep Generator — Horizontal Amp — Calibrator	6
400	500	Power Supply — CRT — Blanking	7
600	809	Vertical Pre-Amplifier and Channel Switching	3
810	850	Vertical Output Amplifier	4
901	920	CH1 Vertical Attenuator	2-1
951	970	CH2 Vertical Attenuator	2-2

The following abbreviations are listed on the component lists and refer to the types of resistors and capacitors.

#### ABBREVIATIONS

BM	Button mica
C	Carbon
CP	Carbon preset
CV	Carbon variable
CER	Ceramic
CF	Carbon Film
CT	Ceramic Trimmer
CM	Cermet thick film
CMP	Cermet preset
E	Electrolytic
Ge	Germanium
MF	Metal Film
MO	Metal Oxide
PC	Polycarbonate
PE	Polyester
PP	Polypropylene
PPT	Polypropylene Trimmer
PS	Polystyrene
SM	Silver mica
WW	Wire-wound
WWP	Wire-wound preset
WWV	Wire-wound variable

In order to give a basic introduction to the instrument circuitry and the relationship between the major sub-circuits, a block diagram, designated Diagram 1 and description is included. Each block bears the title and number of a major sub-circuit.

At the end of this section, Interconnection Diagram 10 shows the wiring arrangements within the instrument.

On diagram 3, for diagnostic purposes typical mean d.c. voltages are shown thus  $\overline{V}$  with position and traces centred. Where circuit symmetry exists, the voltage is shown on one side or one channel only.

When the SEC/Div switch is set to the EXT X position, use a voltmeter of 20k $\Omega$ /volt sensitivity or higher.

AC voltages are shown thus ---mV pk—pk under the following conditions.

1. CH1 OFF
2. CH2 set to 10mV/div with DC coupling.
3. SECS/DIV switch set to 2ms/div.
4. Squarewave input signal of 1kHz at 50mV pk—pk to display 5 vertical divisions.

### 4.2 BLOCK DIAGRAM (Diagram 1)

Diagram 1 shows the circuit functions in block format. The vertical signal to be viewed is applied to either CH1 or CH2 INPUT and is then routed through an attenuator and pre-amplifier to the channel switching circuit, which feeds the vertical output amplifier driving the CRT.

The selected signal is picked off and fed to the trigger amplifier and Schmitt, so that the sweep generator can be triggered from the vertical signal. The sweep generator output is amplified by the horizontal amplifier and applied to the X plates.

A blanking signal, which lasts for the duration of flyback, hold off and time spent waiting for a trigger signal, comes from the sweep generator circuit and is fed to the blanking amplifier. Blanking for the chop transients is achieved by the path from the channel switching to the blanking amp.

A detailed description of each circuit block now follows.

**4.3 VERTICAL ATTENUATORS (Diagrams 2-1 & 2-2)**  
 Since CH1 and CH2 attenuators are similar, this description is for CH1 with CH2 circuit references in brackets.

The vertical input signal is coupled to the attenuators via the input switch — DC (direct coupling) — GND (the amplifier input is grounded, not the signal input) — AC (via a d-c blocking capacitor C903 (C953); CH1 has the additional OFF position.

The attenuator is basically composed of 2 sections, a 0.9 divider R911 (R961) and R908 (R958) and a potential divider chain CM901 (CM951). The use of a 0.9 divider permits a small coupling capacitor (C909/C959) to be connected to the gate of the F.E.T. (TR601b/701b).

The energy in C959 when charged/discharged from a high d.c. voltage is thus kept too small to damage the input of the F.E.T.

In the 5, 10 and 20mV positions R911 (R961) and R908 (R958) form a 0.9 divider which is compensated by C909 (C959) and C911 (C961). R910 (R960) brings the input resistance to 1MΩ on these ranges.

Thick film network CM901 (CM951) forms a 0.09 divider in 50, 100 and 200mV/div; 0.009 divider in 0.5, 1 and 2V/div; 0.0009 divider in 5, 10 and 20V/div. Compensation is provided by C904 (C954), C905 (C955) and C907 (C957). C902 (C952) adjusts the input capacitance of the main potential divider to equal that of the 0.9 divider.

R901 (R951), R903 (R953), R913 (R963) and R914 (R964) minimise high frequency ringing.

CCT REF	PART NUMBER	DESCRIPTION	Starting Ser. No.
S901	See Section 6 Parts List	DC-GND-AC-OFF VOLTS/DIV	
S902	260-1937-00		
SK901	131-2268-00	Socket CH1 INPUT	

**CIRCUIT 2-2 ELECTRICAL PARTS LIST**

CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.
C951	285-0870-00	120 p	PS	2	350	
C952	281-0155-01	2-22 p	PPT		500	
C953	285-1179-00	22 n	PE	10	630	
C954	281-0155-01	2-22 p	PPT		500	
C955	281-0155-01	2-22 p	PPT		500	
C956	285-0870-00	120 p	PS	2	350	
C957	281-0155-01	2-22 p	PPT		500	
C958	285-0884-00	29 p	PS	1 p	350	
C959	285-1178-00	330 p	PS	2	500	
C961	281-0155-01	2-22 p	PPT		500	
C962	281-0804-00	10 p	CER	Op5	400	

**CIRCUIT 2-1 ELECTRICAL PARTS LIST**

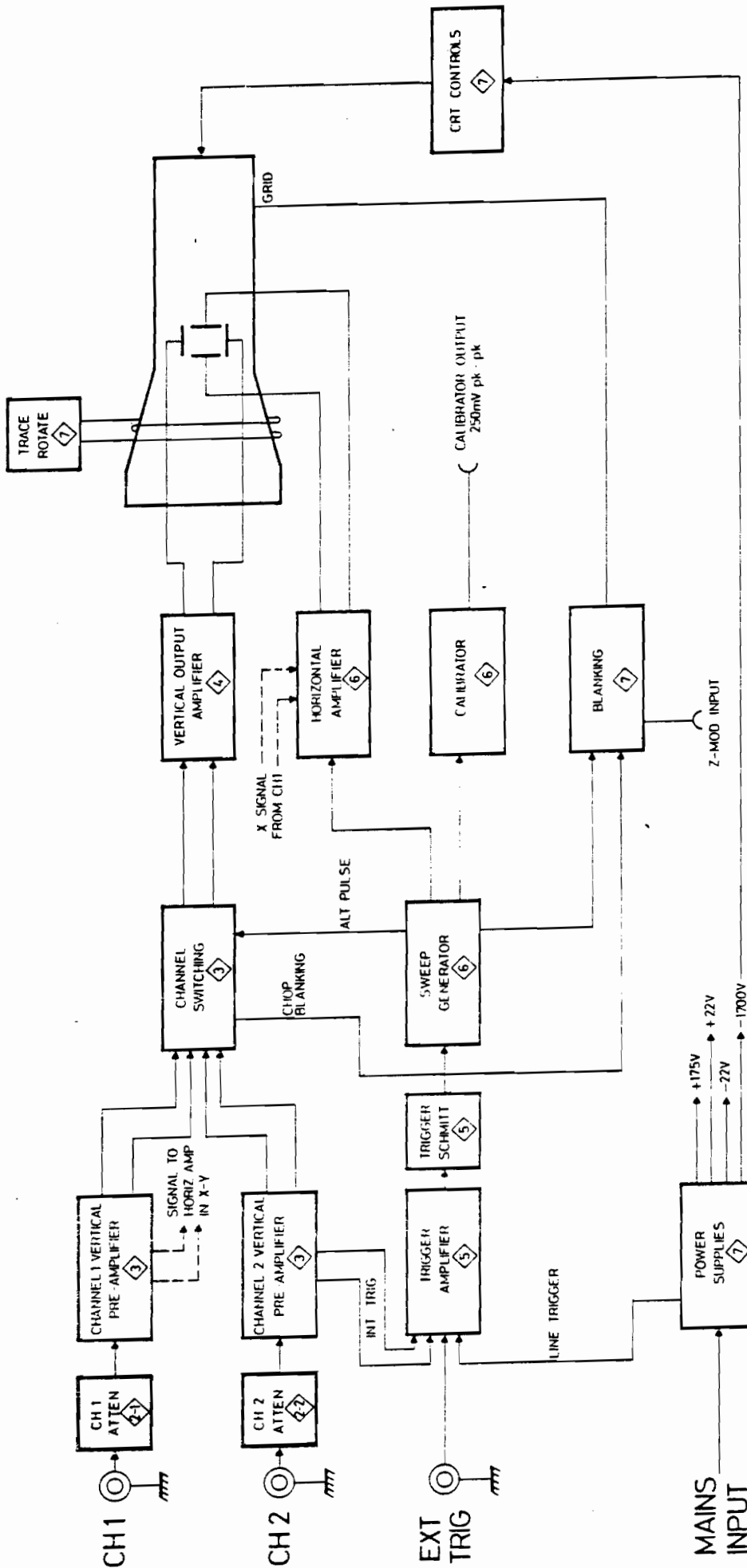
CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.
C901	285-0870-00	120 p	PS	2	350	
C902	281-0155-01	2-22 p	PPT		500	
C903	285-1179-00	22 n	PE	10	630	
C904	281-0155-01	2-22 p	PPT		500	
C905	281-0155-01	2-22 p	PPT		500	
C906	285-0870-00	120 p	PS	2	350	
C907	281-0155-01	2-22 p	PPT		500	
C908	285-0884-00	29 p	PS	1 p	350	
C909	285-1178-00	330 p	PS	2	500	
C911	281-0155-01	2-22 p	PPT		500	
C912	281-0804-00	10 p	CER	Op5	400	

CCT REF	PART NUMBER	VALUE Ohms	TYPE	TOL %	RATING W	Starting Ser. No.
R901	317-0510-01	51 R	CF	5	125 m	
R902	317-0390-01	39 R	CF	5	125 m	
R903	317-0181-01	180 R	CF	5	125 m	
R904	307-0632-00	908 k	Thick film network			
R905		84 k				
R906		8k14				
R907		902 R				
R908		2M70				
R910	307-0631-00	1M5	Thick film network			
R911		300 k				
R913	317-0390-01	39 R	CF	5	125 m	
R914	317-0101-01	100 R	CF	5	125 m	
R915	325-0288-00	243 R	MF	1	100 m	
R916	325-0291-00	768 R	MF	1	100 m	

CCT REF	PART NUMBER	VALUE Ohms	TYPE	TOL %	RATING W	Starting Ser. No.
R951	317-0510-01	51 R	CF	5	125 m	
R952	317-0390-01	39 R	CF	5	125 m	
R953	317-0181-01	180 R	CF	5	125 m	
R954	307-0632-00	908 k	Thick film network			
R955		84 k				
R956		8k14				
R957		902 R				
R958		2M70				
R960	307-0631-00	1M5	Thick film network			
R961		300 k				
R963	317-0390-01	39 R	CF	5	125 m	
R964	317-0101-01	100 R	CF	5	125 m	
R965	325-0288-00	243 R	MF	1	100 m	
R966	325-0291-00	768 R	MF	1	100 m	

CCT REF	PART NUMBER	DESCRIPTION	Starting Ser. No.
S951	See Section 6 Parts List	DC-GND-AC VOLTS/DIV	
S952	260-1937-00		
SK951	131-2269-00	Socket CH2 INPUT	

NOTE: X-Y IN D1011 VERSION ONLY.



1 BLOCK DIAGRAM  
D1010 - D1011



#### 4.4 VERTICAL PRE-AMPLIFIERS (Diagram 3)

CH1 and CH2 amplifiers are very similar so a description is given for CH2, with the differences noted. CH1 circuit references are shown in brackets.

The input signal from the attenuator is applied to TR701b (TR601b) which converts the input into a push-pull signal with TR701a (TR601a). R715 (R615) sets the F.E.T. stage gain, R714 (R614) sets their d.c. balance for the gain switching.

IC701a (IC601a) and IC701b (IC601b) are a shunt feedback push-pull amplifier feeding the gain switching stage IC701c (IC601c) and IC701d (IC601d). The gain of this latter stage is  $x1$ ,  $x2$  and  $x4$  depending on the position of CH2 (CH1) attenuator switch. In D1011,  $x5$  collector gain switching is also done in this stage.

IC702a (IC602a) and IC702c (IC602c) are emitter followers driving the cascode signal multiplexing stage IC702d (IC602d), IC702e (IC602e) and IC703 (IC603). Trigger pick off (CH2 only) occurs from this stage. R745 (R645) is the channel vertical gain adjustment and C731 (C631) adjusts the high frequency response. In D1011, the collector output currents are transposed when the -CH2 switch is depressed, and the vertical position current is also applied to these collectors.

The output from IC703 (CH2) and IC603 (CH1) is applied to TR820 and TR823 (Diagram 4), a pair of emitter followers driving the output cascode amplifier comprising TR821, TR822, TR810 and TR811.

The conduction of transistor arrays IC603 and IC703 is controlled by the channel switching bistable IC771a and IC771b.

In the CH1 OFF mode, IC703a and d conduct, passing CH2 signal to the output amplifier; IC603b and c conduct blocking CH1 signal from the output. When the CH1 is multiplexed off screen, the stage currents flow through resistors R627, R628, R639, R648. The latter two are used to connect CH1 as the  $\bar{X}$  Channel in the X-Y mode, by forcing the multiplexed stage into the condition described above, through the X-Y mode switch interlocks.

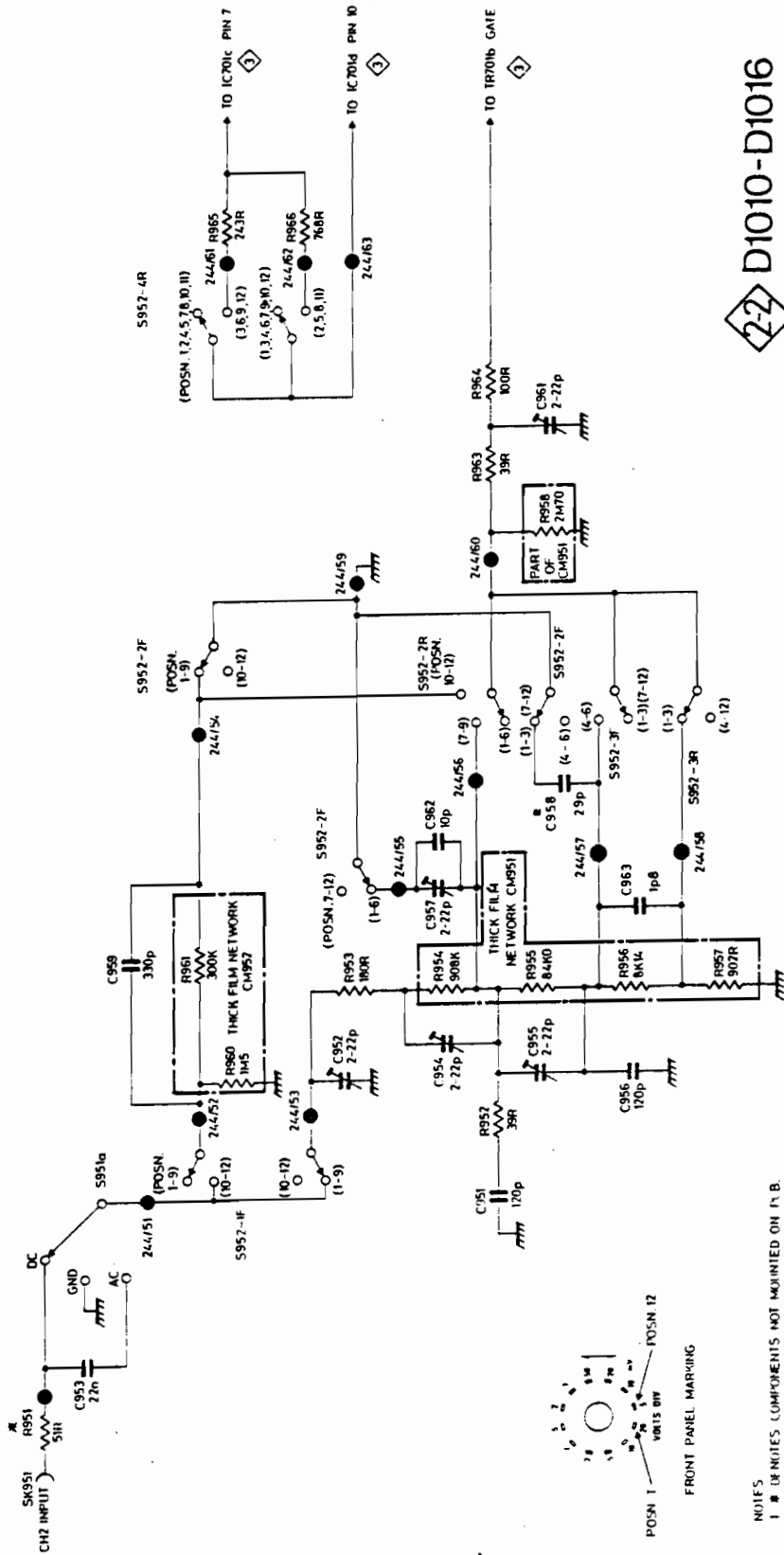
*Note: When in the dual trace mode, both channels are continuously active up to the multiplexing stage. Large signals and/or a dc offset on either channel may interact with the other channel even though the trace is off the screen and not being displayed (alternate mode).*

In the ADD mode (D1011 only) both IC603a and d and IC703a and d conduct, so that the sum of CH1 and CH2 signals is applied to the output, to ensure correct d.c. levels, TR770 also conducts in this mode.

In the dual trace mode at sweep speeds of 1ms/div and faster, an alternate pulse is applied to IC771e via D775. This causes the bistable to switch alternately at the end of each trace, thus alternately displaying CH1 then CH2. At sweep speeds of 2ms and slower, an emitter coupled multivibrator IC771c and d, running at about 140kHz drives IC771e via D776. This causes the bistable to switch at a frequency of 70kHz displaying CH1 for 14 $\mu$ s and then CH2 for 14 $\mu$ s. To ensure that the transients are not seen when switching between channels, a blanking signal is taken from IC771d to the blanking amplifier.



RESISTORS	951	952	960	961	955	964	963	958	963	964	965	966
CAPACITORS	953	951	952	964	955	962	961					
MISC.	SK951	S951a	S952		(CM951)	S952	S952	(CM951)	S952			
PCBZ44	R951	51	52	53	55	57	58	59	60	61	62	63



**D1010-D1016**  
**CH2 VERTICAL ATTENUATOR**

- NOTES
1. # DENOTES COMPONENTS NOT MOUNTED ON P.C.B.
  2. SWITCH IS SHOWN IN FULLY ANTICLOCKWISE POSITION (POSN 1) WHEN VIEWED FROM FRONT PANEL.
  3. ● DENOTES PCB TAKE OFF POINT & REFERENCE - 244/No., R951
  4. REFER TO (X) FOR INTERCONNECTION ROUTES

CCT REF	PART NUMBER	VALUE Ohms	TYPE	TOL %	RATING W	Starting Ser. No.
R781	317-0102-01	1k0	CF	5	125 m	
R782	317-0163-01	16 k	CF	5	125 m	
R783	317-0163-01	16 k	CF	5	125 m	
R784	317-0752-01	7k5	CF	5	125 m	
R785	317-0222-01	2k2	CF	5	125 m	
R786	317-0223-01	22 k	CF	5	125 m	
R787	317-0331-01	330 R	CF	5	125 m	
R788	317-0223-01	22 k	CF	5	125 m	
R789	317-0153-01	15 k	CF	5	125 m	
R790	317-0223-01	22 k	CF	5	125 m	
R791	317-0162-01	1k6	CF	5	125 m	
R792	317-0152-01	1k5	CF	5	125 m	
R793	317-0751-01	750 R	CF	5	125 m	
R794	317-0472-01	4k7	CF	5	125 m	
R795	317-0472-01	4k7	CF	5	125 m	
R796	317-0182-01	1k8	CF	5	125 m	
R797	317-0332-01	3k3	CF	5	125 m	
R798	317-0562-01	5k6	CF	5	125 m	
R799	317-0823-01	82 k	CF	5	125 m	
R801	317-0184-01	180 k	CF	5	125 m	
R802	317-0822-01	8k2	CF	5	125 m	
R803	317-0101-01	100 R	CF	5	125 m	

CCT REF	PART NUMBER	DESCRIPTION	Starting Ser. No.
△ S601		x1 x5 CH1	
△ S701	260-1938-00	x1 x5 CH2	
△ S702		-CH2	
△ S703		ADD	

S901b See Mechanical Parts List CH1 OFF position

TR601<sup>a</sup><sub>b</sub> 151-1118-00 FET Dual Selected SU2603

TR701<sup>a</sup><sub>b</sub> 151-1118-00 FET Dual Selected SU2603

△ TR770 151-0320-01 MPS6518 PNP

CIRCUIT 3 ELECTRICAL PARTS LIST

CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.	CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.
C600	281-0710-00	10 n	CER	+80 -20	250		C770	285-0734-00	100 n	CER	+50 -25	30	
C601	281-0710-00	10 n	CER	+80 -20	250		C771	281-0745-00	4p7	CER	0p5	400	
							C772	285-1018-00	22 p	PS	1 p	350	
							C773	285-0776-00	27 p	PS	1 p	350	
							C774	281-0744-00	6p8	CER	0p5	750	
							C775	285-0874-00	470 p	PS	5	125	
C603	281-0710-00	10 n	CER	+80 -20	250		C776	281-0710-00	10 n	CER	+80 -20	250	
C604	281-0710-00	10 n	CER	+80 -20	250		C777	285-0843-00	30 p	PS	2 p	350	
							C778	285-1018-00	22 p	PS	1 p	350	
C630	281-0804-00	10p0	CER		500	738951	C779	290-0707-00	22 μ	ELEC	+100 -10	25	
C631	281-0155-01	2-22 p	PPT		500								
C632	285-0854-00	10C		2p0	350	746151	C781	281-0734-00	100 n	CER	+50 -25	30	738621
C701	281-0710-00	10 n	CER	+80 -20	250	738621	C800	290-0707-00	22 μ	ELEC	+100 -10	25	
							C801	290-0627-00	22 μ	ELEC	+100 -10	40	741051
C703	281-0710-00	10 n	CER	+80 -20	250								
C704	281-0710-00	10 n	CER	+80 -20	250								
C731	281-0155-01	2-22 p	PPT		500								

CCT REF	PART NUMBER	VALUE V	DESCRIPTION	RATING	Starting Ser. No.	CCT REF	PART NUMBER	VALUE	DESCRIPTION	Starting Ser. No.
D601	152-0843-00		CE 1104		738621	IC701	156-0197-02		Transistor Array RCA 3086	
D603	152-0062-01	75	IN914/IN4148	50 mA		IC702	156-0197-02		Transistor Array RCA 3086	
D604	152-0062-01	75	IN914/IN4148	50 mA		IC703	156-0197-02		Transistor Array RCA 3086	
D701	152-0843-00		CE 1104		738621	IC771	156-0197-02		Transistor Array RCA 3086	
D702	152-0052-01	75	IN914/IN4148	50 mA	738621					
D703	152-0062-01	75	IN914/IN4148	50 mA						
D704	152-0062-01	75	IN914/IN4148	50 mA						
						L800	108-0932-00	160 μH	Fixed Inductor	
						L801	108-0932-00	160 μH	Fixed Inductor	
D770	152-0416-00	8V2	Zener BZY88	400 mW						
D771	152-0062-01	75	IN914/IN4148	400 mW						
D772	152-0062-01	75	IN914/IN4148	400 mW						
D773	152-0062-01	75	IN914/IN4148	400 mW						
D774	152-0062-01	75	IN914/IN4148	400 mW						
D775	152-0062-01	75	IN914/IN4148	400 mW						
D776	152-0062-01	75	IN914/IN4148	400 mW						
IC601	156-0197-02		Transistor Array RCA 3086							
IC602	156-0197-02		Transistor Array RCA 3086							
IC603	156-0197-02		Transistor Array RCA 3086							



10 DIVISIONS ON  
MONITOR OSCILLOSCOPE

ALTERNATE MODE

I/p CH1 4KHz sq waves (not shown)  
I/p CH2 1KHz sq waves trigger from CH2  
Timebase = 0.1mS/div.  
MONITOR OSCILLOSCOPE = 0.5mS/DIV.

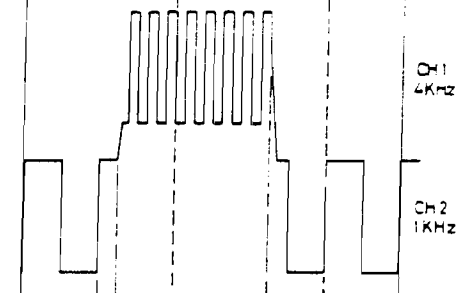
(A) (B & C)



Trigger points of timebase



(D)

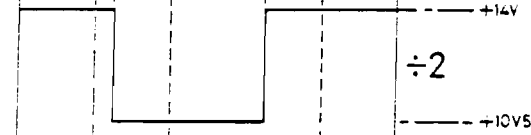


blanking

CH1  
4KHz

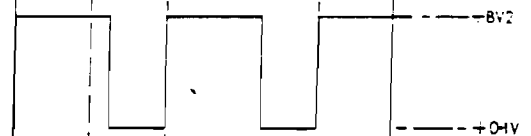
CH2  
1KHz

(E)



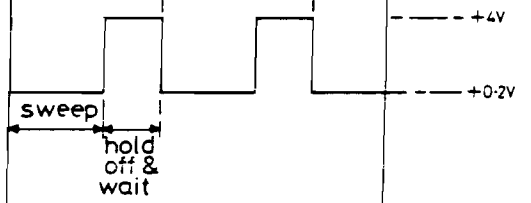
÷2

(F)



10 divisions  
of sweep  
0.1mS/div.

(G)



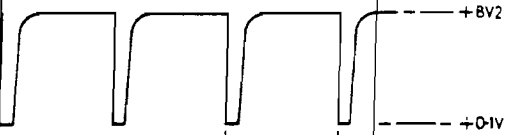
CHOP MODE

(E)



÷2

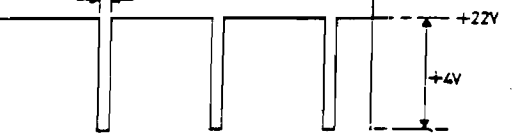
(F)



300ns

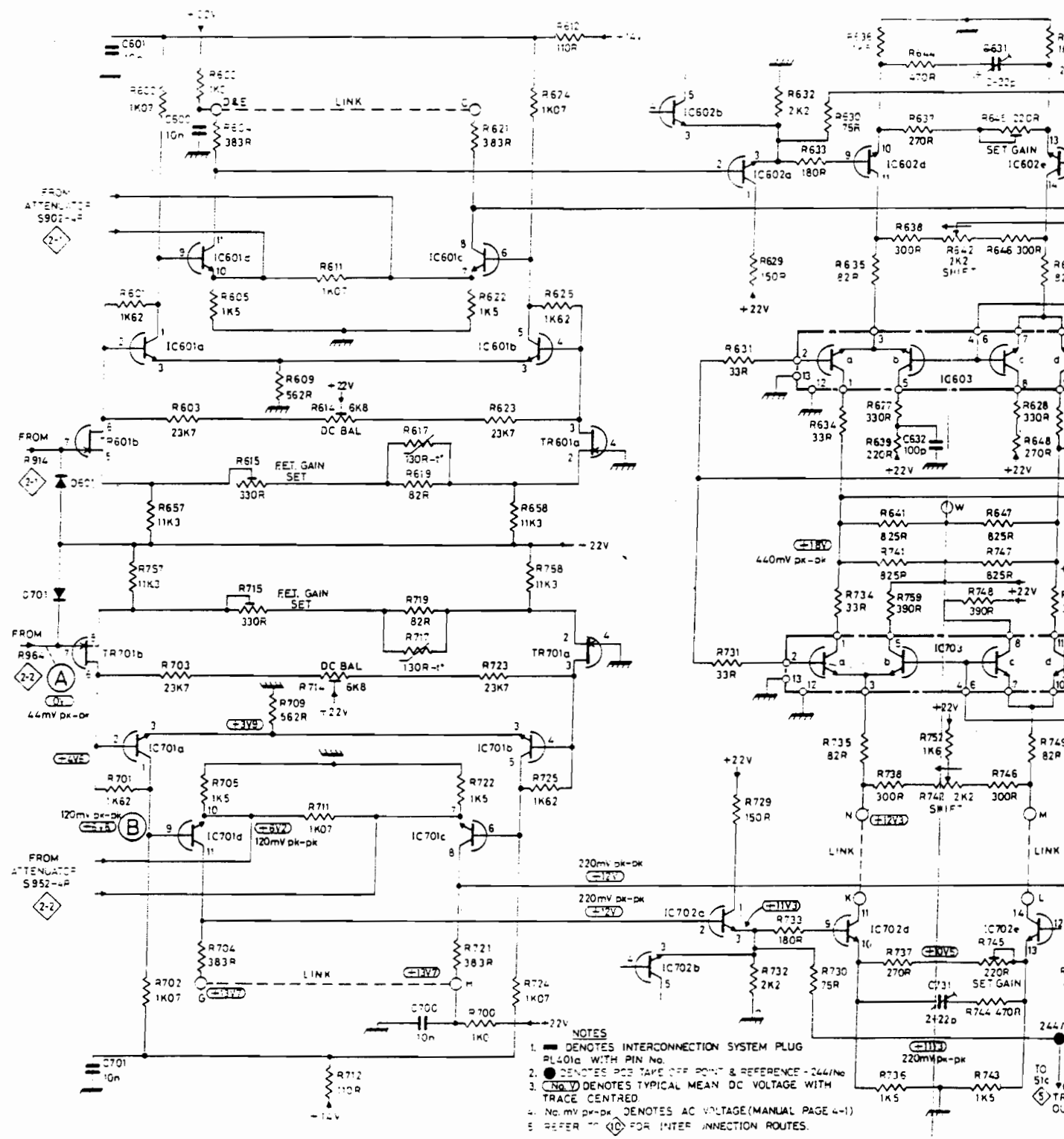
7.2µS

(H)



CHOP WAVEFORMS USE x10 PROBE AT TEST POINTS  
MONITOR OSCILLOSCOPE IN CAPITALS  
oscilloscope under test in lower case

RESISTORS	601	602	600	604	657-a	611	614	714	617	717	619	719	621	622	722	625	624	612	629	631	632	633	636	638	641	643	747	649		
				603	605	757-b	609	615	711	712			623	721	725	724			731	733	634	627	735	644	752	748	645	746	628	749
			703		705		615	711					723	700	724				729	730	641	737	736			646	745	648	651	
CAPACITORS	601	600									700																			
	701																													
M-SC	IC601a	IC601d				IC601e			IC601c	IC601b	TR601a	IC602b	IC602a	IC603	IC602d	IC603	IC602e													
D601	TR601b	IC701a	IC701d			IC701e			IC701c	IC701b	TR701a	IC702b	IC702a	IC703	IC702d	IC703	IC702e													
D701	TR701b	IC701a	IC701d			IC701e			IC701c	IC701b	TR701a	IC702b	IC702a	IC703	IC702d	IC703	IC702e													
PCB244																														







- 4.5 VERTICAL OUTPUT AMPLIFIER (Diagram 4)  
 Emitter followers TR820 and TR823 drive the output cascode amplifier TR821, TR822, TR810 and TR811. R826 sets the gain, whilst adjustments of R827 and C822 optimise the high frequency corner. When the BEAM FINDER is depressed, the current in this stage is reduced, restricting the deflection to within the graticule area.

CCT REF	PART NUMBER	DESCRIPTION	TYPE	Starting Ser. No.
TR810	151-0676-00	Motorola 8F467	NPN	
TR811	151-0676-00	Motorola 8F467	NPN	
TR820	151-0317-01	Plastic 8C109C	NPN	
TR821	151-0680-00	Plastic 2N2369A	NPN	
TR822	151-0680-00	Plastic 2N2369A	NPN	
TR823	151-0317-01	Plastic 8C109C	NPN	

## CIRCUIT 4 ELECTRICAL PARTS LIST

CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.
C810	285-0795-00	220 n	PE	20	250	741051

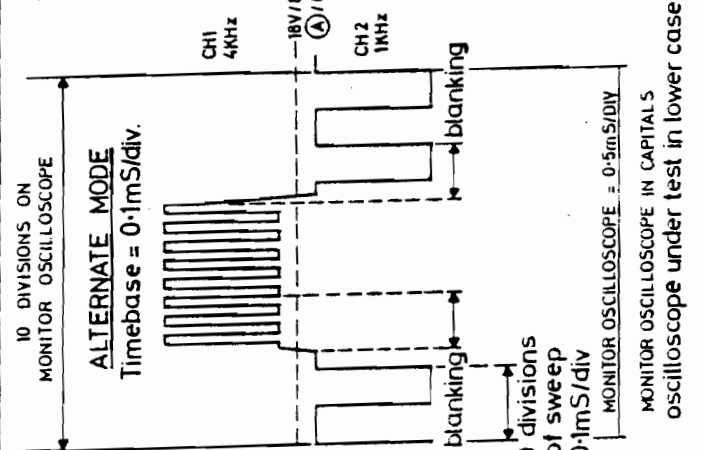
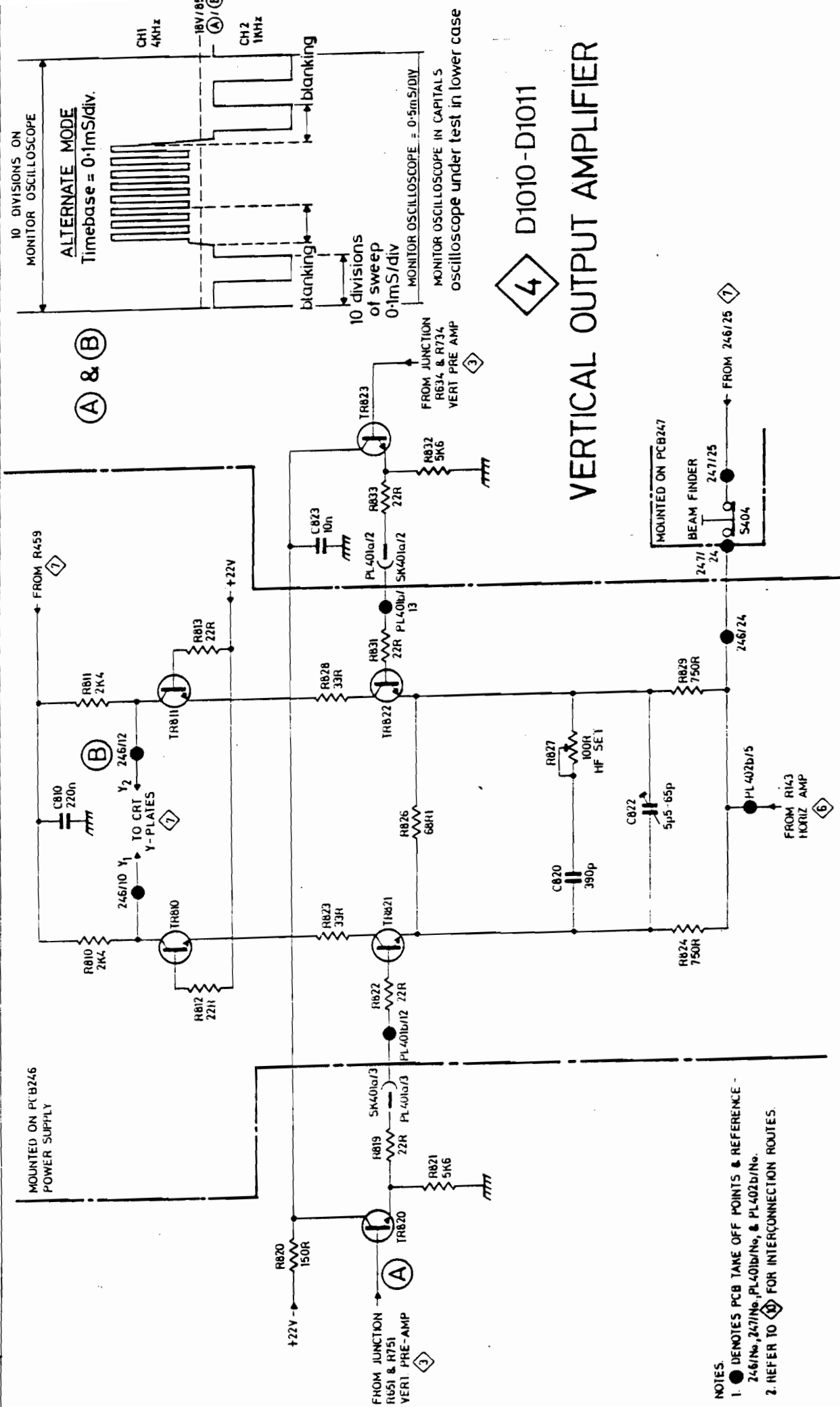
C820	285-1063-00	390 p	PS	1	350	
C822	281-0229-00	5p5-65p	PPT		500	
C823	281-0710-00	10 n	CER	+80 -20	250	

CCT REF	PART NUMBER	VALUE Ohms	TYPE	TOL %	RATING W	Starting Ser. No.
R810	308-0812-00	2k4	WW	2	5	
R811	308-0812-00	2k4	WW	2	5	
R812	317-0220-01	22 R	CF	5	125 m	
R813	317-0220-01	22 R	CF	5	125 m	

R819	317-0220-01	22 R	CF	5	125 m	
R820	317-0151-01	150 R	CF	5	125 m	
R821	317-0562-01	5k6	CF	5	125 m	
R822	317-0220-01	22 R	CF	5	125 m	
R823	317-0330-01	33 R	CF	5	125 m	
R824	325-0305-00	750 R	MF	1	500 m	
R826	325-0303-00	68R1	MF	1	100 m	
R827	311-1970-00	100 R	CP	20	50 m	
R828	317-0330-01	33 R	CF	5	125 m	
R829	325-0305-00	750 R	MF	1	500 m	
R831	317-0220-01	22 R	CF	5	125 m	
R832	317-0562-01	5k6	CF	5	125 m	
R833	317-0220-01	22 R	CF	5	125 m	

S404 Refer to Diagram 7

RESISTORS	820	821	819	822	812	810	826	827	811	813	831	833	832
CAPACITORS						810	820	822	829	823			
MISC.	TR820	5K401a/3	PL401a/3	TR810	TR821	TR810	TR811	TR822	TR811	TR822	S404	SK401a/2	PL401a/2
PCB246				PL401b/12	10	PL402b/5	12	24	PL401b/13	24	25		
PCB247													

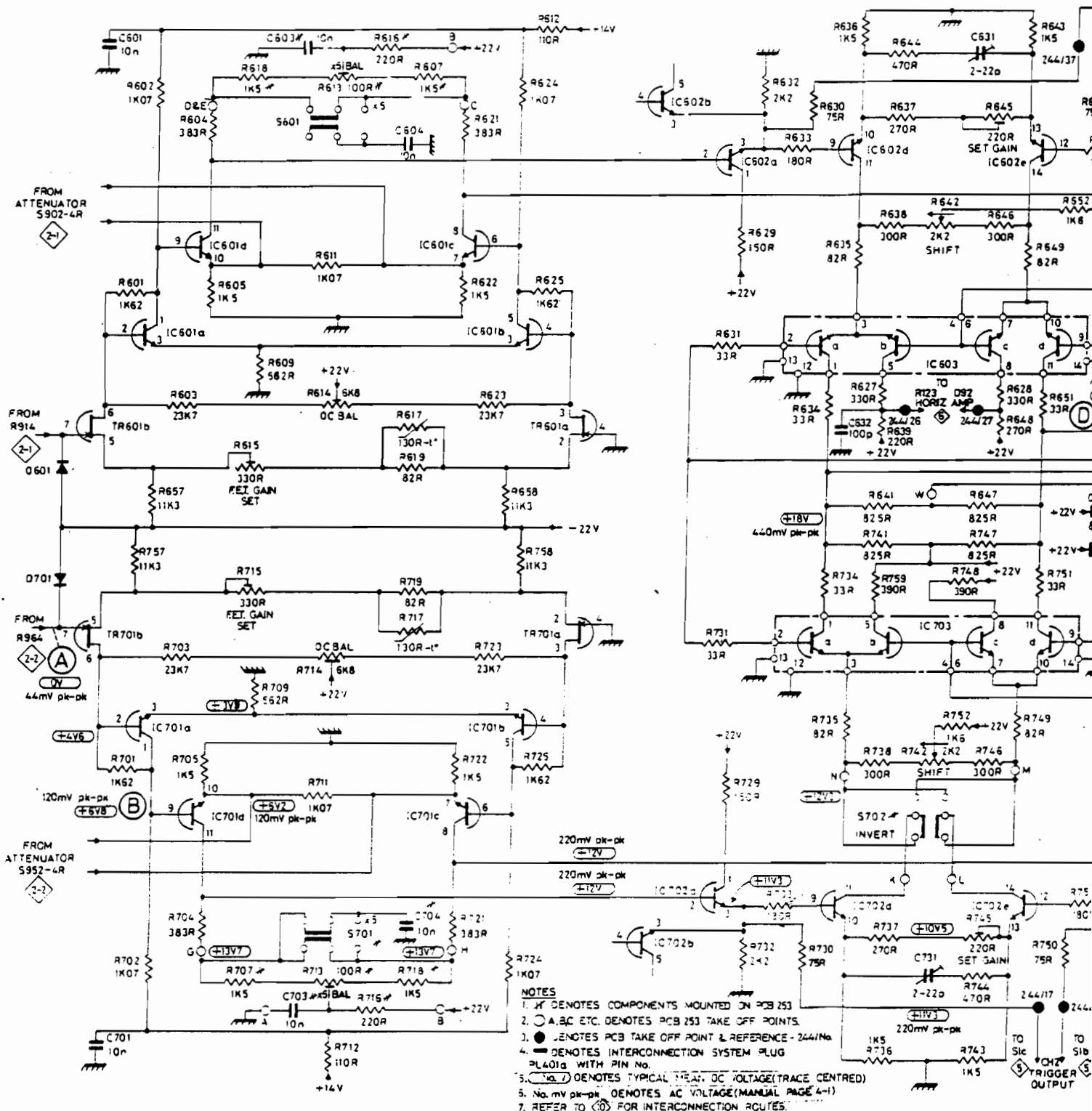


# 4 D1010-D1011

## VERTICAL OUTPUT AMPLIFIER

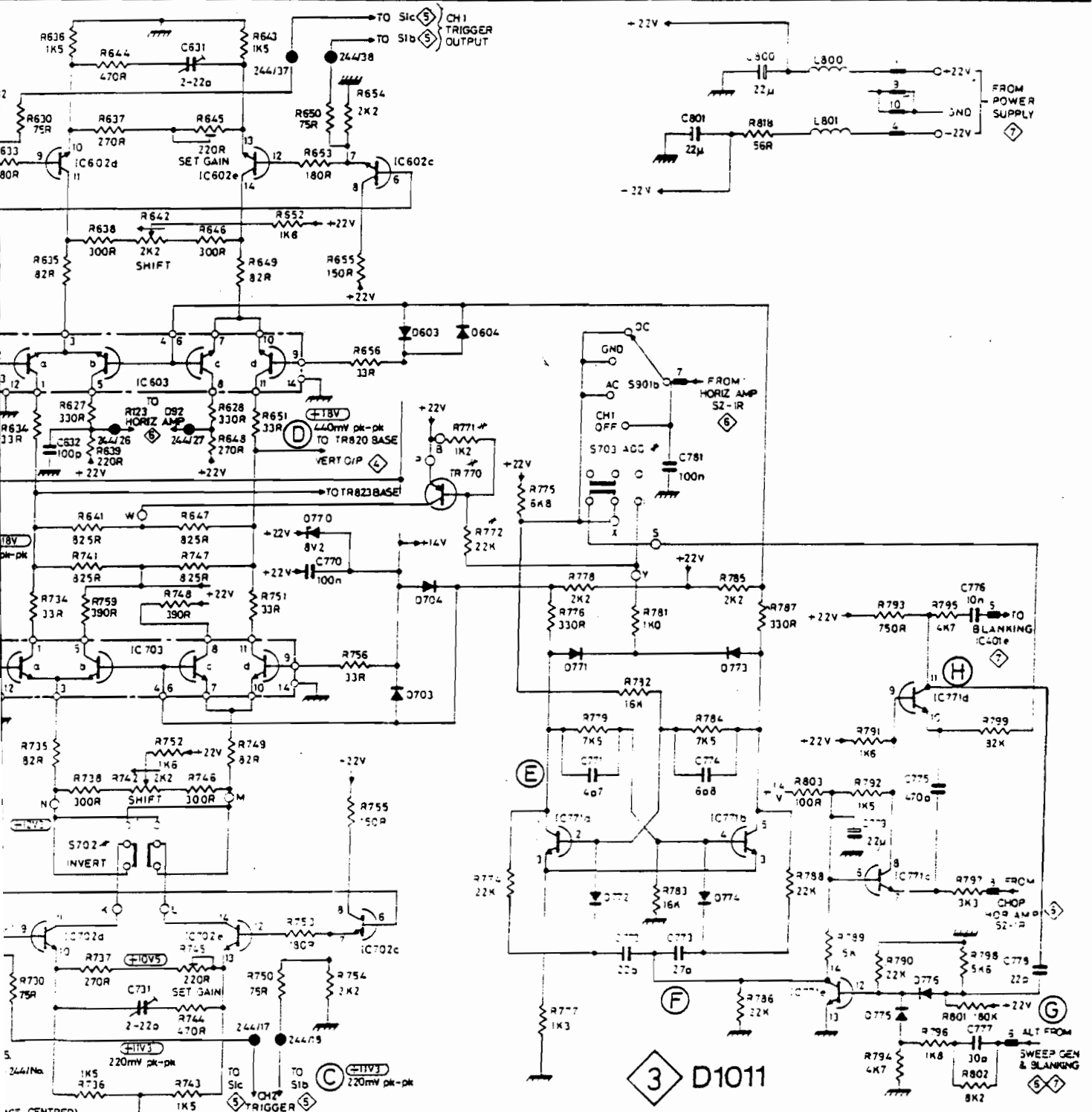
- NOTES.
1. ● DENOTES PCB TAKE OFF POINTS & REFERENCE - 246/10, 247/10, PL401b/10, & PL402b/10.
  2. REFER TO (A) FOR INTERCONNECTION ROUTES

RESISTORS	602	604	605	618	709	615	713	616	607	621	719	524	629	632	630	635	741	746	636	643	649	6			
	601	603	609	707	613	715	712	617	718	622	723	626	631	633	634	627	738	745	747	644	645	647	628		
	701	703		657	658	611	714	717		623	722	725	731	733	759	734	639	742	752	744	748	537	648		
	702	705	704	757	758	614	711	716		619	721	612	724	729	732	730	735	641	737	736	743	749	638		
																							646	750	754
CAPACITORS	601			603		604																		631	
		701	703			704																			
MISC.	D601			IC601d	IC601e				IC601c																
	O701	TR601b	IC601a	IC701d	IC701e	S601			IC701c	IC601b	TR701a		IC602b	IC702a					S702	IC702d			IC602e	IC602d	
	TR601b		IC701a			S701				IC701b			IC702b	IC602a						IC603			IC702e		
PCB244	●																			28			27		17



- NOTES**
1.  $\square$  DENOTES COMPONENTS MOUNTED ON PCB 253
  2. A, B, C ETC. DENOTES PCB 253 TAKE OFF POINTS.
  3.  $\bullet$  DENOTES PCB TAKE OFF POINT & REFERENCE - 244/No.
  4.  $\square$  DENOTES INTERCONNECTION SYSTEM PLUG PL401a WITH PIN No.
  5.  $\square$  DENOTES TYPICAL TRACED DC VOLTAGE (TRACE CENTRED)
  6. No. mV pk-pk DENOTES AC VOLTAGE (MANUAL PAGE 4-1)
  7. REFER TO  $\square$  FOR INTERCONNECTION ROUTES.

630	635	741	748	516	543	649	652	650	554	771	775	778	781	818	785	787	791	793	795	799		
633	634	627	738	745	747	644	645	647	628	551	653	655	782	784	788	788	792	790	797	797		
733	759	734	639	742	752	744	748	537	648	751	753	656	755	772	774	777	789	794	798	801		
730	735	641	737	736	743	749	638	642	646	750	754	756	754				786	803		802		
				531		770								771	801	774	800			776		
														772	773					775	777	778
632		731												781			779					
	5702		IC602e		IC602d				IC602c		D603		D604	5301b		IC771b		IC771d				
	IC702d		IC603		IC702e		IC602d		D603		D604		D604	5703		IC771c		IC771e		IC771d		
	IC703		IC703						TR770		D704		D704	IC771a		IC771e		D775		D775		
									IC702c		D703		D703	0771		0774		L800		L801		
														0772								



VERTICAL PRE-AMPLIFIER & CHANNEL SWITCHING

**TRIGGER AMPLIFIER (Diagram 5)**

This circuit produces trigger pulses which are derived from either an internal signal from CH2, and external signal connected to the TRIG or EXT X INPUT, or line voltage signal. Control switches give selection of trigger level polarity, and signal source. In all the sweep speed positions of SECS/DIV switch S2, when the trigger source switch S1 b and c is set to NORM, push-pull signals from CH2 of the Vertical Amplifier are a.c. coupled to both bases of IC1c and IC1d which form a long-tailed pair. In the EXT and LINE positions the signals from TR1 are a.c. coupled to the base of IC1d and the base of IC1c is a.c. coupled to ground.

The polarity switch S4 selects the sweep triggering for either a positive or negative-going signal. In the positive position the signal from the collector of IC1d is coupled to the shunt feedback stage IC1e via D4, and in the negative position the signal from the collector of IC1c is coupled via D5.

The output from IC1e is directly coupled to a second long-tailed pair IC1a and IC1b and collector of IC1a is directly coupled to shunt feedback stage TR2.

When SECS/DIV switch S2 is set to EXT X position coupling switch S1a is available to select DC, AC or GROUND. The signal from the EXT TRIG/EXT X socket SK1 is fed to the base of TR76 in the horizontal amplifier via emitter follower TR1. When S1a is set to DC, the voltage at SK1 may be up to  $\pm 0.3V$  with a shunt impedance of 280k due to resistor and transistor tolerances. Therefore take care when this input is coupled to high impedance circuits. For example, if the EXT X socket is connected to CH1 or CH2, and d.c. coupled, vertical deflections of up to  $\pm 0.25V$  will be produced, which on high sensitivity ranges above 50mV/div means that the trace will be deflected off the screen. A lower impedance source will lessen the amount of deflection, but no deflection will occur when either input is a.c. coupled.

Switch S3 selects three modes of trigger operation — AUTO NORM and TV.

In the AUTO position the output of IC2c is at 0V and diodes D13 and D14 are off. The voltage across the LEVEL control R33 is equal to the peak to peak value of the output voltage at the collector of TR2 minus the base emitter voltages of the two peak rectifier transistors TR3 and TR4. This means that the range of the LEVEL control is 1V approximately less than the peak to peak value of the output voltage at TR2. The triggering point can only be adjusted to within 0.5V of either peak of the waveform regardless of its size or shape. The timebase will always trigger automatically provided that the signal is larger than 0.5 div in internal trigger mode or 100mV in external trigger mode. The peak rectifiers operate successfully with waveforms up to 1000:1 mark/space ratio.

In the NORM mode, the output of IC2 is at +5V and diodes D13 and D14 are conducting, therefore the LEVEL control varies the voltage at the base of IC1b from +1.2V to +3.5V. This enables the output voltage swing of the trigger amplifier to be selected from any point on the triggering waveforms up to  $\pm 4$ divs on internal trigger and  $\pm 0.8V$  on the external trigger from the mean level.

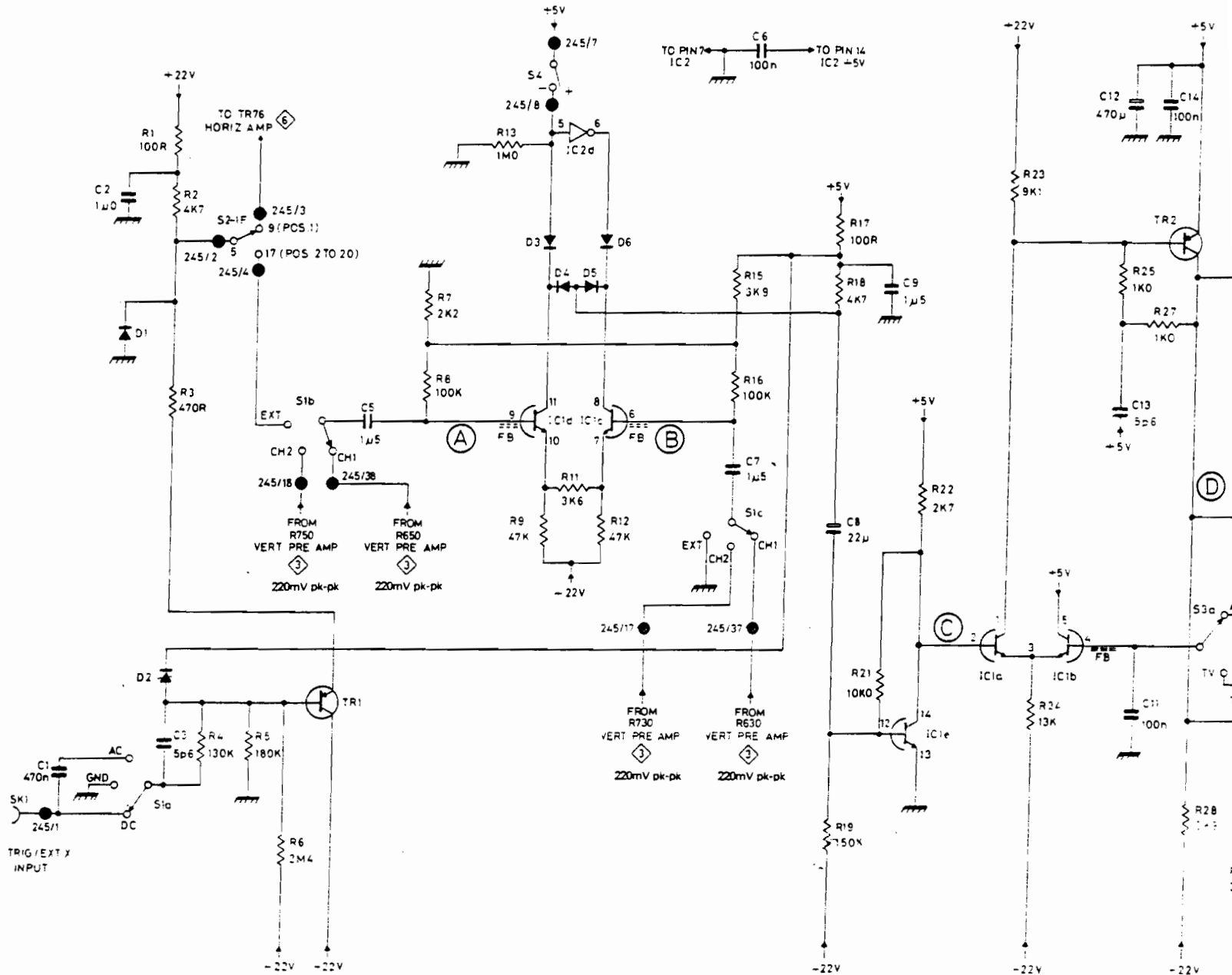
The TV position directly connects the output of the negative peak rectifier TR4 to the base of IC1b to ensure that TR4 only conducts during the sync pulses of the TV signal. The collector waveform of TR4 displays sync pulses only with all the picture information removed.

For sweep speeds up to 100 $\mu$ s/div the sync pulses are integrated by R39 and C25 which gives a greater output from the broader field pulses. Separation of the line and field pulses is improved by passing them through CMOS inverters IC2a and IC2b.

For sweep speeds faster than 100 $\mu$ s/div the sync pulses are fed directly to the input of IC2a through D9 and C25.

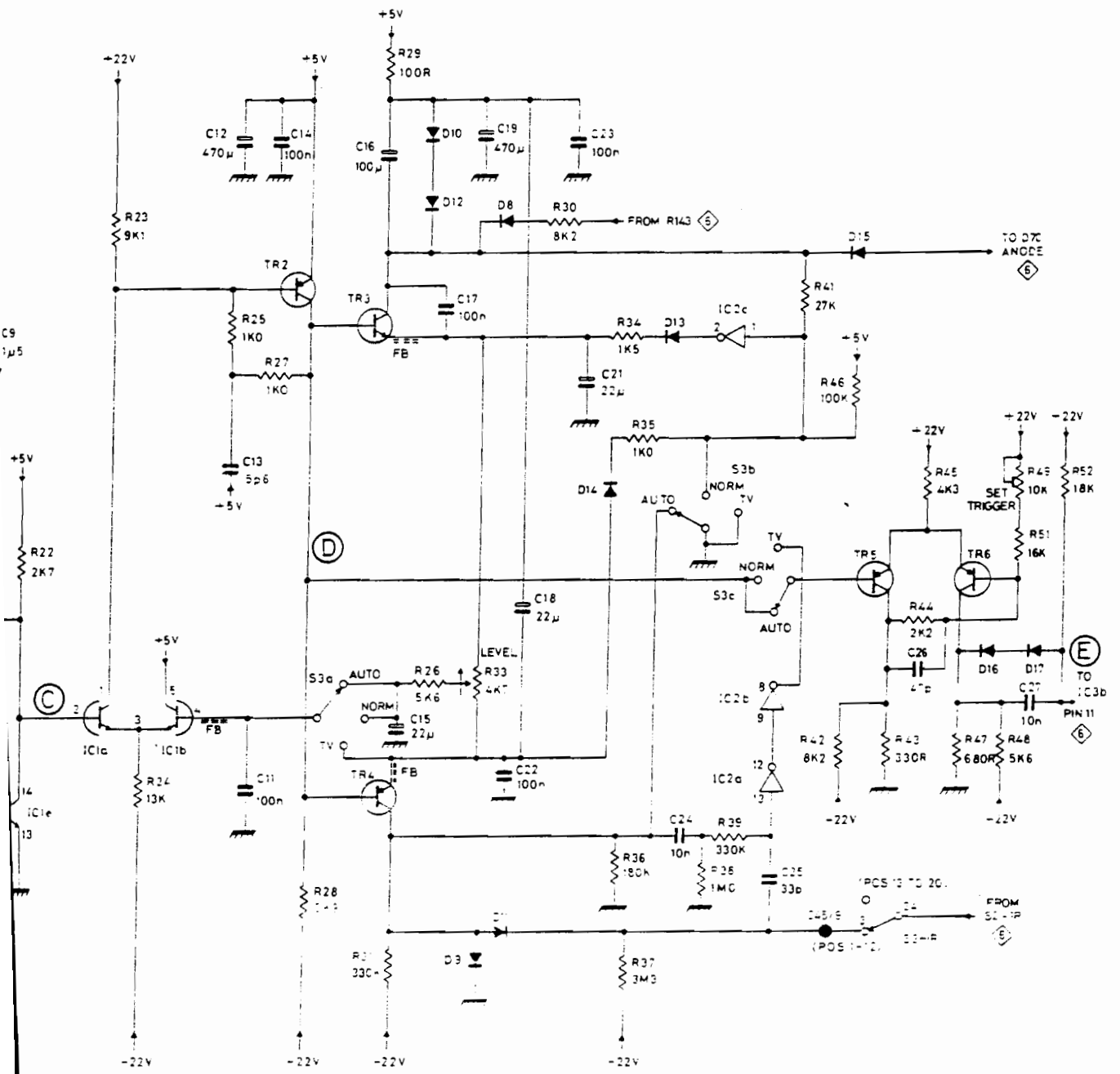
The output from emitter TR2 or IC2b is fed to a Schmitt trigger circuit TR5 and TR6 which provides a fast positive-going edge to trigger the timebase circuit.

RESISTORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
CAPACITORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
MISC	D1	S2-1F	S1b	TR1	S4	IC2d	D3	D4	D5	D6	S1c	IC1e	IC1a	TR2														
SK1	S1a																											
PCB245		2	3	4	18	38		7	8	17		37																



- NOTES**
- \* DENOTES COMPONENTS NOT MOUNTED ON PCB
  - DENOTES PCB TAKE OFF POINT & REFERENCE - 245/No.
  - DENOTES INTERCONNECTION SYSTEM PLUG PL402c WITH PIN No.
  - REFER TO (◇) FOR INTERCONNECTION ROUTES
  - No. mV pk-pk DENOTES AC VOLTAGE (MANUAL PAGE 4 - 1)

23	25	27	28	29	28	33	30	34	39	41	45	49	52
24					31			36	38	42	43	47	51
	12	14		16				23			26		27
	11			15		17	18	21	24	25			
	13					22							
IC1e	IC1a		TR2	TR3	D10	D8		IC2c	D15		TR6		
	IC1b		S3a	D12	D9	D11	D14	S3b	IC2b	TR5	S2-1P	D16	D17
			TR4				D13	IC2a					



5 D1010-D1011

TRIGGER AMPLIFIER





#### 4.7 SWEEP GENERATOR — HORIZONTAL AMPLIFIER (Diagram 6)

The output from the Schmitt trigger circuit is fed to the clock input of a D type flip flop, IC3b, with its D input permanently connected to +5V and both S and CLR are high in the NORM position of S3. The first positive going edge at the clock input will give a positive going output at Qb, and a negative going edge at Qb cuts off the discharge transistor TR73 to allow the timing capacitors C74, C76 and C77 to be charged by a constant current from the collector of TR72. The value of the constant current is determined by the emitter resistors of TR72 which are switched by the SECS/DIV control S2. The voltage at the collectors of TR72 and TR73 therefore rises linearly and is fed via source follower TR74 and diode D78 to the base of TR75 which is normally bottomed and therefore holds Sa of IC3a high during the sweep. When diode D78 conducts and cuts off TR75, Sa goes low and makes Qa low, clearing IC3b and makes Qb go high turning on TR73 which in turn discharges the timing capacitors. At the same time, Qb goes low, cutting off D76 which allows the hold-off capacitors C79 and C78 to discharge through R95 and eventually clears IC3a, making Qa high; the timebase is then ready for the next triggering edge.

In the AUTO & TV positions of S3 when no triggering waveform is present, the peak rectifiers TR3 and TR4 are non-conducting and D15 is cut off; in this condition when Qa and CLRb go high at the end of the hold-off period, TR71 is cut off and Sb goes low. This makes Qb go low and restarts the sweep which free runs in the absence of trigger signals. When a trigger signal big enough to operate the Schmitt trigger is present at TR2 collector, the average current through the peak rectifiers TR3 and TR4 is sufficient to make D15 conduct and cut off D70; this bottoms TR71 and switches IC3b from the free running condition to the triggered conditions.

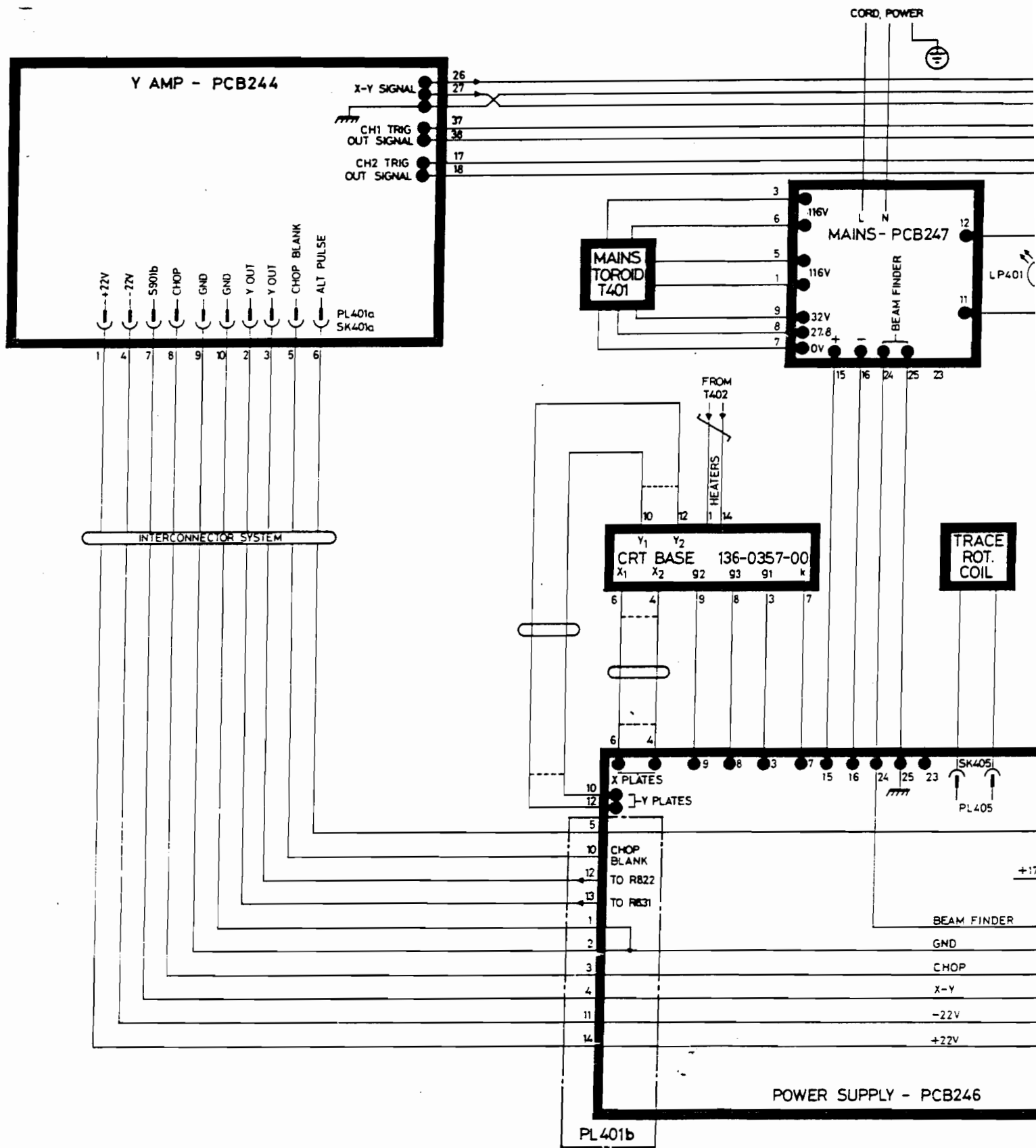
The timebase at the output of source follower TR74 is fed via D81 to an emitter follower TR76 and is then mixed with the horizontal position voltage at the base of shunt feedback stage TR77. The gain of this stage can be increased 5 times by operating S5 which increases the value of the feedback resistor. The output of TR77 is fed via S6a to the base of IC4d which, together with IC4 forms a long tailed pair. The collectors of IC4c & d feed the emitters of TR79 and TR81 which form a cascode long tailed pair to drive the X plates.

With D1011, when either S2 is in the EXT X position or S6 is in the X-Y position, D72 is cut off and the current through R70 flows into both D73 and D71. This cuts off TR71 which brightens up the trace by making Qb low and also stops the trace by turning on the discharge transistor TR73. In the EXT X position a signal fed into the EXT/EXT X socket is fed via TR1 to the base of TR76.

In the X-Y position the base of the output cascode long tailed pair is connected to the collector of TR79, and the emitter and base of TR79 are fed with a push-pull signal from CH1 output of the Vertical Amplifier and the sensitivity is set up by R124.

#### 4.8 CALIBRATOR (Diagram 6)

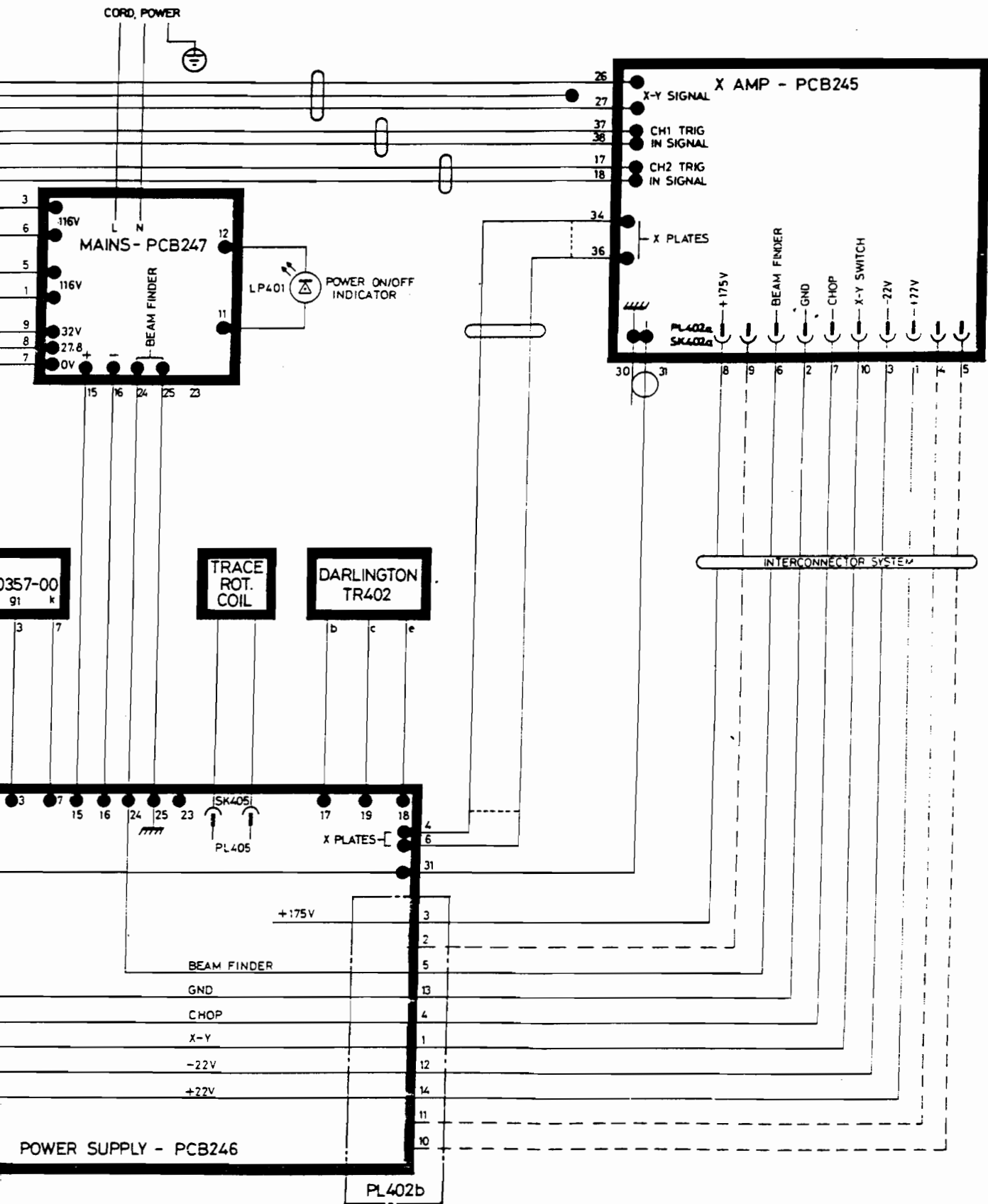
IC4a and IC4b are a Schmitt trigger circuit to which is fed the sweep waveform at the output of TR74. The Schmitt is arranged to give a positive-going output at the collector of IC4a at approximately halfway up the sweep waveform. The output at IC4a collector is accurately attenuated by an adjustable attenuator to give an output amplitude of 250mV at SK71. The temperature coefficient of the attenuator is arranged to compensate for the temperature coefficients of the +5V supply and the bottoming potential of IC4a. When using the calibrator to set up the Vertical Amplifier sensitivities or to adjust probe compensations it is essential that no trigger signals are fed to the timebase or the trace will flicker. This can be accomplished by setting the trig source switch to EXT. For adjusting probe compensations, set the sweep speed to 1ms/div.



10

INTERCONNECTION DIAGRAM

D1010-D1011



INTERCONNECTION DIAGRAM

D1010-D1011

CCT REF	PART NUMBER	VALUE Ohms	TYPE	TOL %	RATING W	Starting Ser. No.
R421	317-0332-01	3k3	CF	5	125 m	
R422	317-0102-01	1k0	CF	5	125 m	
R423	317-0332-01	3k3	CF	5	125 m	742301
R424	317-0392-01	3k9	CF	5	125 m	
R425	317-0103-01	10 k	CF	5	125 m	738501
R426	316-0475-01	4M7	CF	10	250 m	
R427	317-0332-01	3k3	CF	5	125 m	
R428	315-0751-01	750 R	CF	5	250 m	
R429	317-0272-01	2k7	CF	5	125 m	742301
R430	317-0273-01	27 k	CF	5	125 m	
R431	317-0473-01	47 k	CF	5	125 m	
R432	317-0222-01	2k2	CF	5	125 m	
R433	317-0273-01	27 k	CF	5	125 m	
R434	317-0102-01	1k0	CF	5	125 m	
R435	317-0102-01	1k0	CF	5	125 m	
R436	301-0680-01	68 R	CF	5	500 m	
R437	301-0685-02	6M8	CF	5	500 m	
R438	311-2026-00	1M0	CV	30	250 m	742301
R439	317-0105-01	1M0	CF	5	125 m	741051
R440	317-0222-01	2k2	CF	5	125 m	742301
R442	311-2034-00	220 k	CP	20	150 m	738501
R444	311-1779-00	1M0	CP	20	50 m	
R445	311-2026-00	1M0	CV	30	250 m	742301
R447	317-0222-01	2k2	CF	5	125 m	
R448	317-0184-01	180 k	CF	5	125 m	
R449	317-0271-01	270 R	CF	5	125 m	
R451	301-0621-02	620 R	CF	5	500 m	
R452	317-0472-01	4k7	CF	5	125 m	
R453	311-2021-00	1k0	CV	20	2	
R454	301-0152-01	1k5	CF	5	500 m	
R457	317-0222-01	2k2	CF	20	125 m	
R458	317-0105-01	1M0	CF	20	250 m	742301
R459	303-0331-01	330 R	CF	5	1	
R461	317-0104-01	100k	CF	5	125 m	

S401 260-1940-00 POWER on/off  
S402 260-1429-01 Range (mains)  
S403 260-1429-01 (mains) Hi-Lo  
S404 260-1940-00 BEAM FINDER

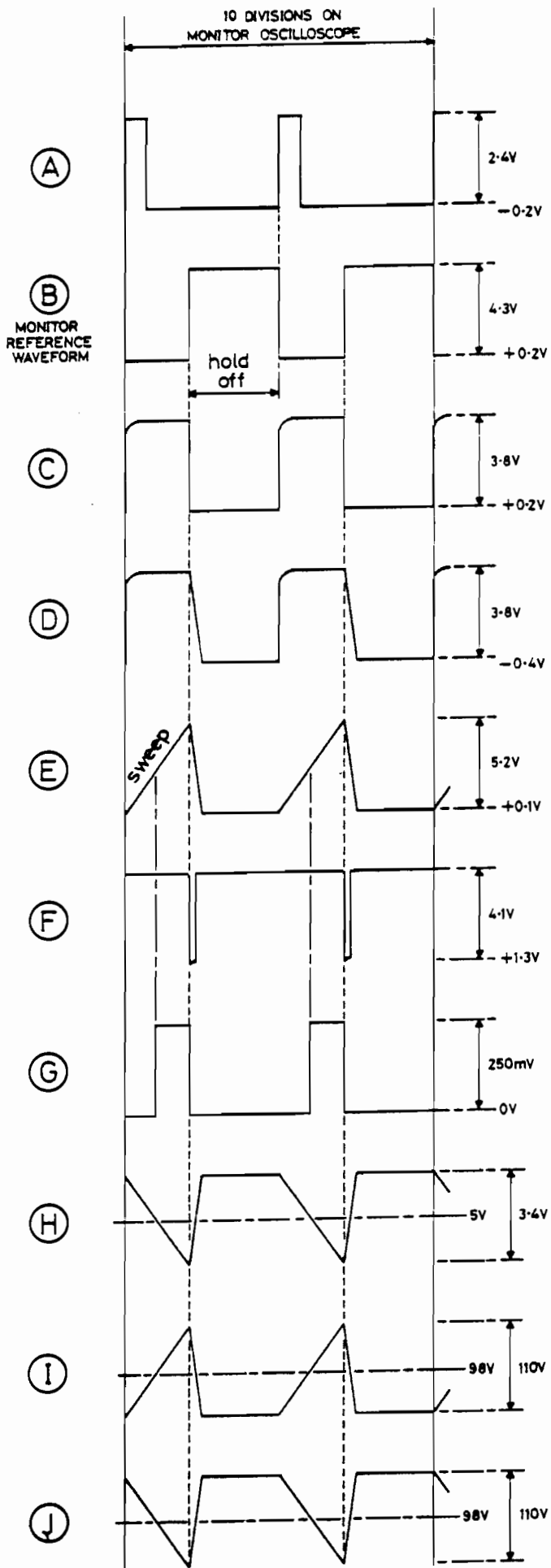
SK401a 175-2216-00 (part of) Connector female 2 x 5 way  
SK402a 175-2216-00 (part of) Connector female 2 x 5 way

SK404 131-2349-00 Socket Z MOD  
SK405 Connector female 2 way  
Part of L404

T401 120-1199-01 Transformer (mains) 741451  
T402 120-1198-00 Transformer (inverter)  
T403 120-1200-00 Transformer (drive)

CCT REF	PART NUMBER	DESCRIPTION	TYPE	Starting Ser. No.
TR401	151-0320-01	MPS 6518	PNP	738501
TR402	151-0675-00	Darlington TIP 120	NPN	
TR403	151-0320-01	MPS 6518	PNP	738501
TR404	151-0681-00	UE C1817	NPN	
TR405	151-0681-00	UE C1817	NPN	

V401 154-0826-00 CRT Mullard P31 D14 250 GH



All waveforms measured with CH1 off &  
CH2 200Hz sine waves 5div. display.

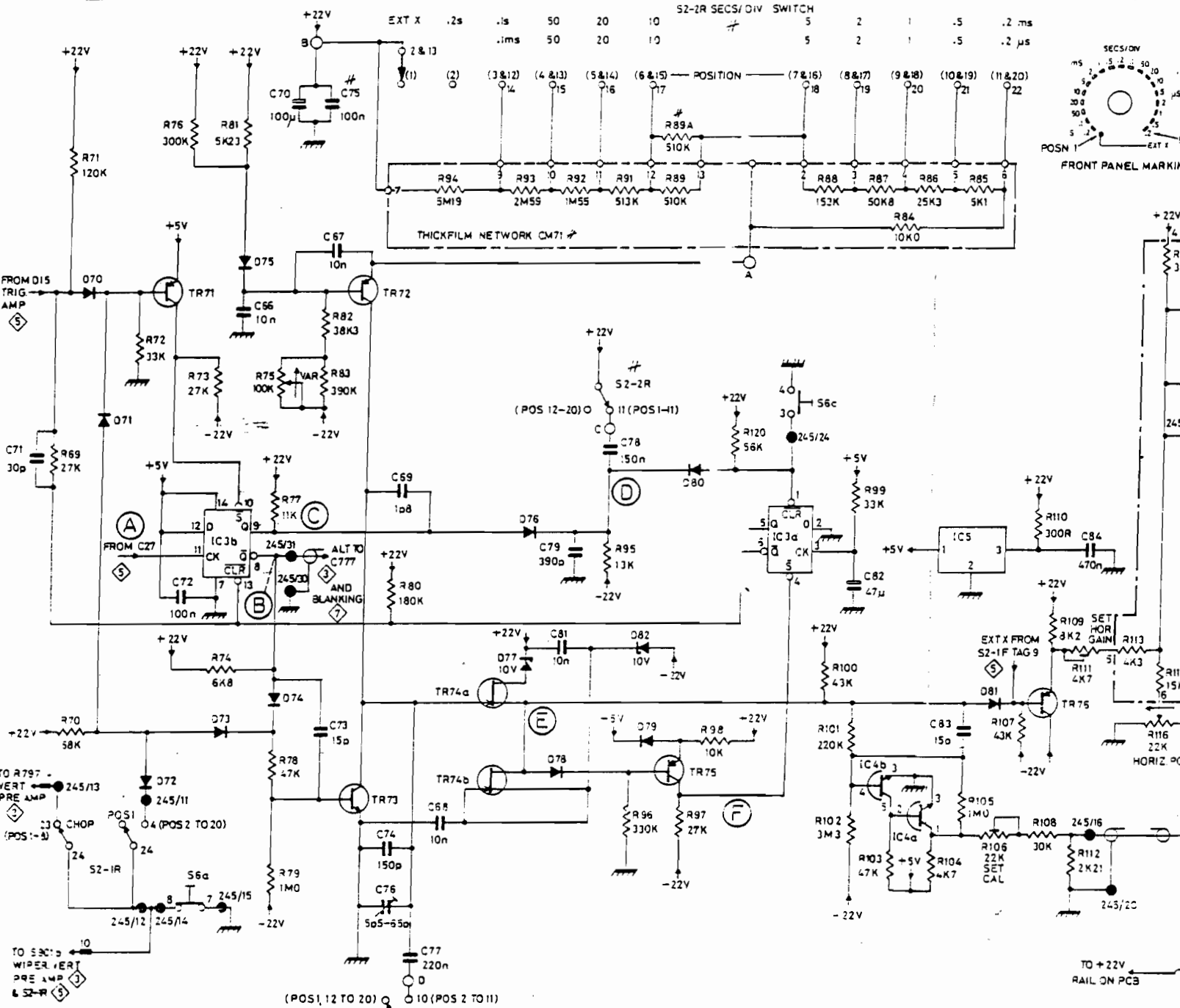
Timebase = 0.2ms/div.

MONITOR OSCILLOSCOPE = 1ms/DIV.

MONITOR OSCILLOSCOPE IN CAPITALS.

oscilloscope under test in lower case

RESISTORS	71	72	76	73	51	75	82	80	34	93	92	91	89	88	87	86	35	110	111	113	
	69		74		77	83					96	95	97	98	100	99		109	112		
	70				78									120	101	102	103	104	105	107	
CAPACITORS	71		72	66	70	67	75	74	89	88	79	78	31		82		83	106	108	84	
MISC.	070	071	S2-1R	IC3b	074	TR72	S2-2F	078	079	082	S6c	TR75	IC3a	IC4b	IC4a	081	TR76				
		072	TR71	075	073	TR73	TR74a	TR74b	076	077	S2-2R	080	IC3a	IC4b	IC4a	081	IC5				
PCB245	13	11	14	15	31	30					24									16	20

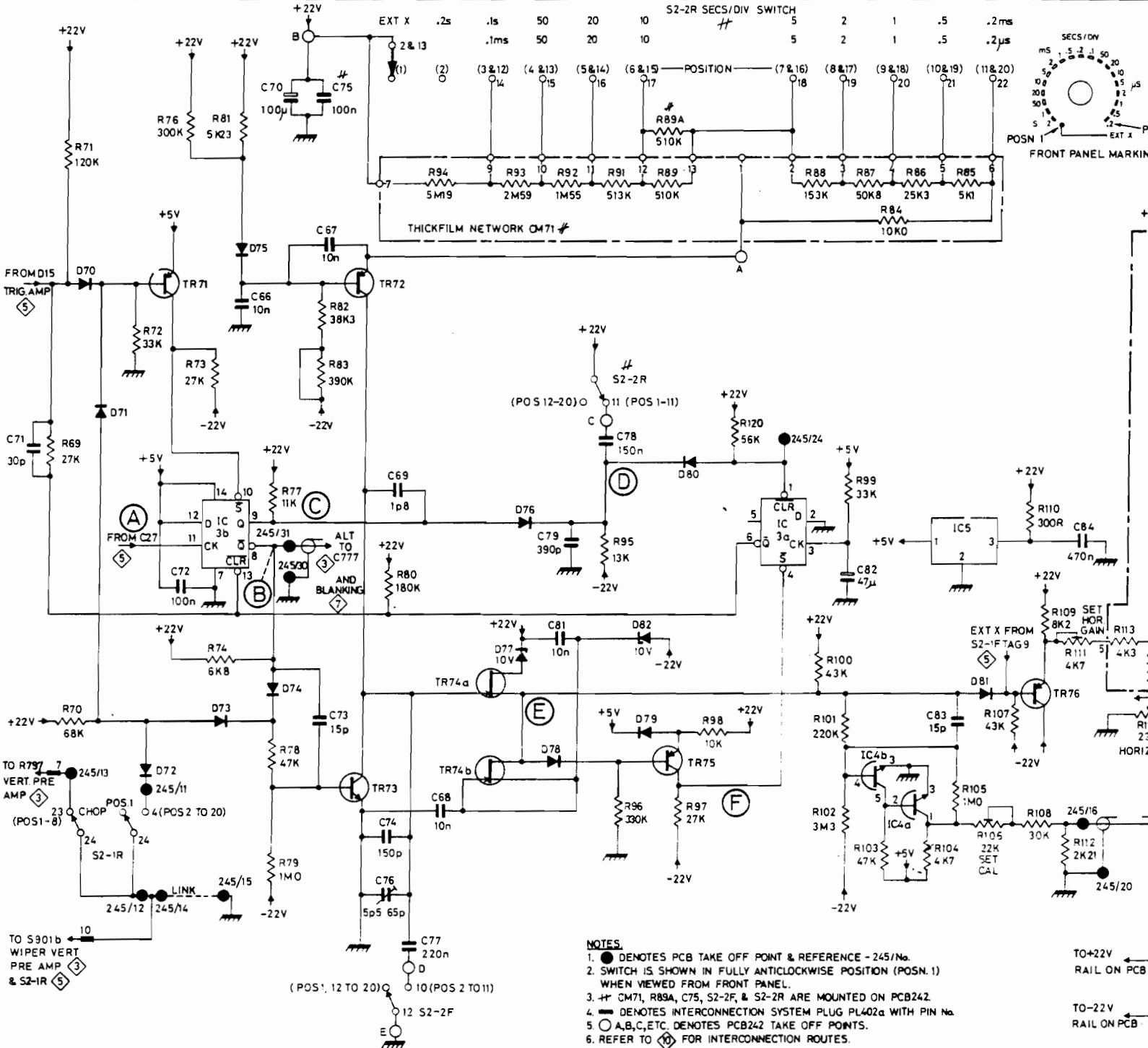


- NOTES**
- DENOTES PCB TAKE OFF POINT & REFERENCE - 245/No.
  - SWITCH IS SHOWN IN FULLY ANTICLOCKWISE POSITION (POSN.1) WHEN VIEWED FROM FRONT PANEL.
  - CM71, R89A, C75, S2-2F, & S2-2R ARE MOUNTED ON PCB245.
  - DENOTES INTERCONNECTION SYSTEM PLUG PL-402a WITH PIN No.
  - A, B, C ETC. DENOTES PCB245 TAKE OFF POINTS.
  - REFER TO ● FOR INTERCONNECTION ROUTES.





RESISTORS	71	72	76	73	81	82	80	94	93	92	91	89	88	87	100	66	85	107	110	111	114		
	69				77	75	83					95	98		101	84		105	103	104	106	115	
	70				78	79						97	120		99	102		108	109	112	113	116	
CAPACITORS		72			66	73		69	68		79	78				82	83					84	
	71				67			74			81												
					70			75	76	77			78										
MISC.	D70	D72	IC3b	D73	D74	D75	TR72	S2-2F	TR73	TR74a	D76	D78	D79	S2-2R	D82	D80	TR75	IC3a	S6c	IC4b	IC5	TR76	L7
	S2-1R	D71	S6a	D75			TR73			TR74b	D77							IC3a	S6c	IC4a	D81		L7
PCB245	13	11	14	15	30	31												24				16	20



- NOTES:**
- DENOTES PCB TAKE OFF POINT & REFERENCE - 245/No.
  - SWITCH IS SHOWN IN FULLY ANTICLOCKWISE POSITION (POSN. 1) WHEN VIEWED FROM FRONT PANEL.
  - ✦ CM71, R89A, C75, S2-2F, & S2-2R ARE MOUNTED ON PCB242.
  - ⊞ DENOTES INTERCONNECTION PLUG PL402a WITH PIN No.
  - A, B, C, ETC. DENOTES PCB242 TAKE OFF POINTS.
  - REFER TO ⊞ FOR INTERCONNECTION ROUTES.

TO+22V  
RAIL ON PCB

TO-22V  
RAIL ON PCB



# SECTION 5

## WIRED ASSEMBLIES

### 5.1 INTRODUCTION

The Wired Assemblies referred to in this section are the circuit boards and switch assemblies.

### 5.2 CIRCUIT BOARDS

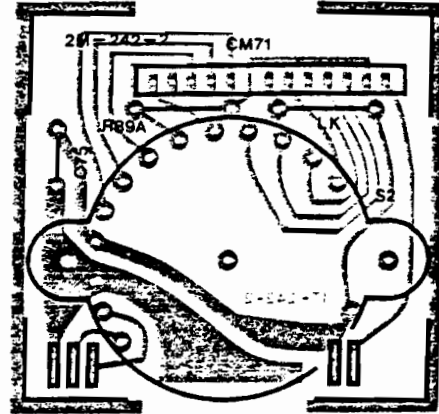
5.2.1 All boards are single sided and are shown full size in three colours, as follows:-

- a) Component references printed on the component side are shown in BLACK.
- b) The track as viewed through the board from the component side is shown in BLUE.
- c) Preset and trimming components are shown ringed in YELLOW.

5.2.2 All the components associated with each board are referred to on a list adjacent to the board.

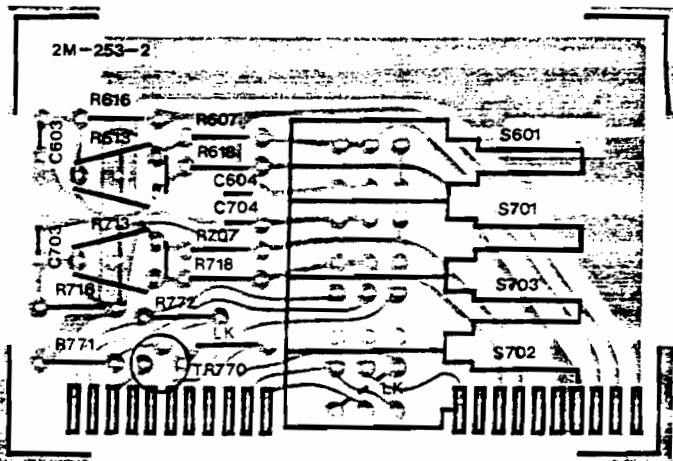
### 5.3 PART NUMBERS

Secs/Div Switch Circuit Board	PC242	388-6307-00
Y Amp Circuit Board	PC244	670-5779-01 (D1010)
		670-5777-01 (D1011)
X Amp Circuit Board	PC245	670-5784-01 (D1010)
		670-5781-01 (D1011)
Power Supply Circuit Board	PC246	670-5786-00 (D1010)
		670-5785-00 (D1011)
Mains Circuit Board	PC247	670-5787-00
Volts/Div Switch Board	PC253	
	(D1011 only)	670-5788-00
Vertical Attenuator Switch		262-1014-00



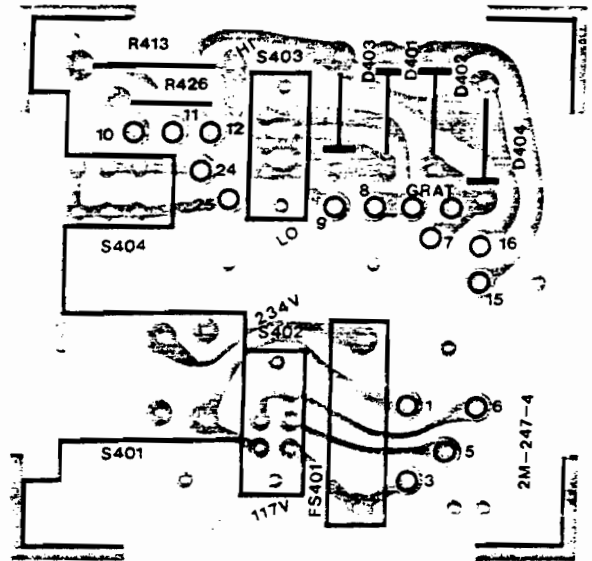
**PC 242**

C75, CM71, R89A, S2



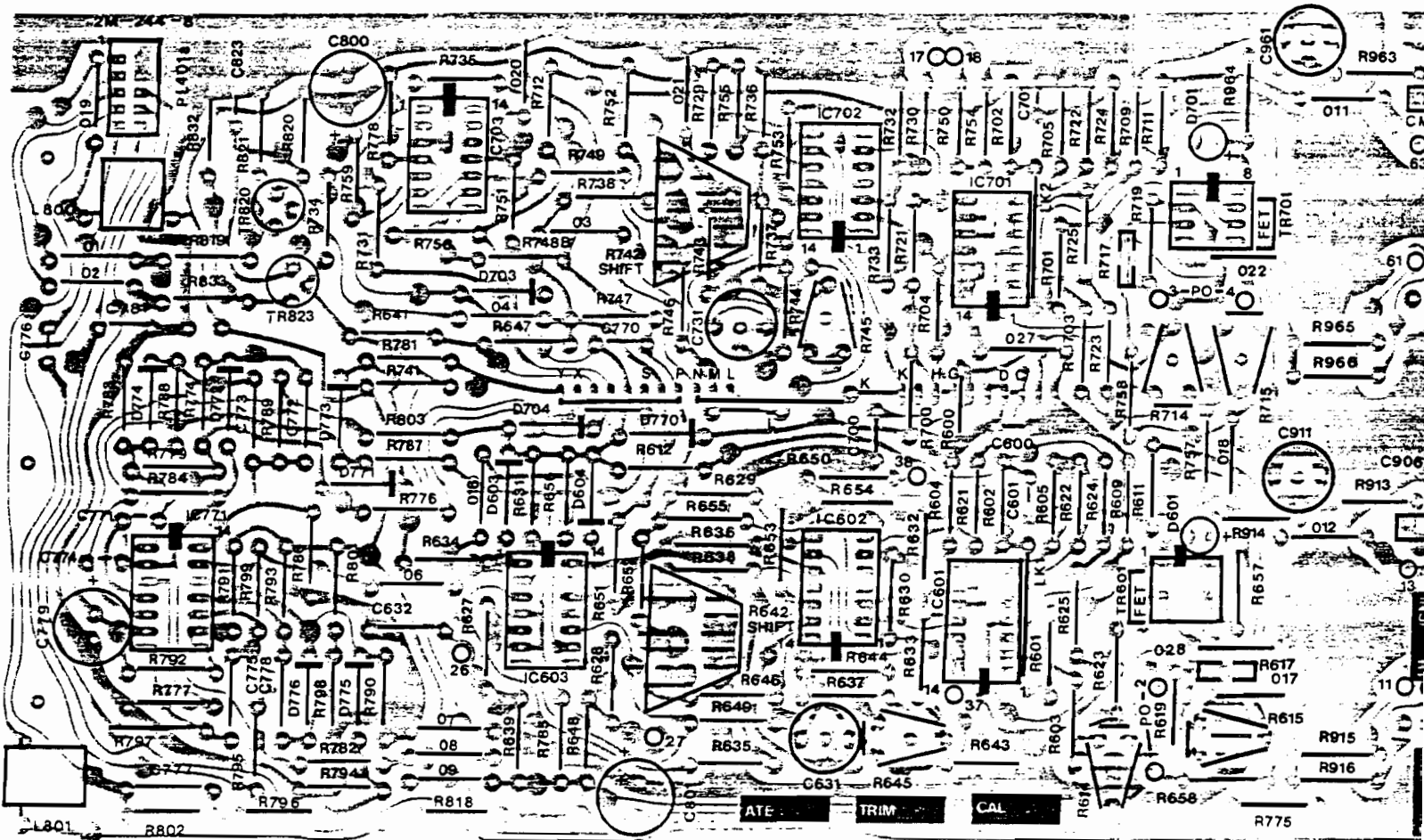
**PC 253 (D1011 only)**

C603, C604, C703, C704, R607, R613, R616, R618, R707, R713, R716, R718, R771, R772, S601, S701, S703, TR770.



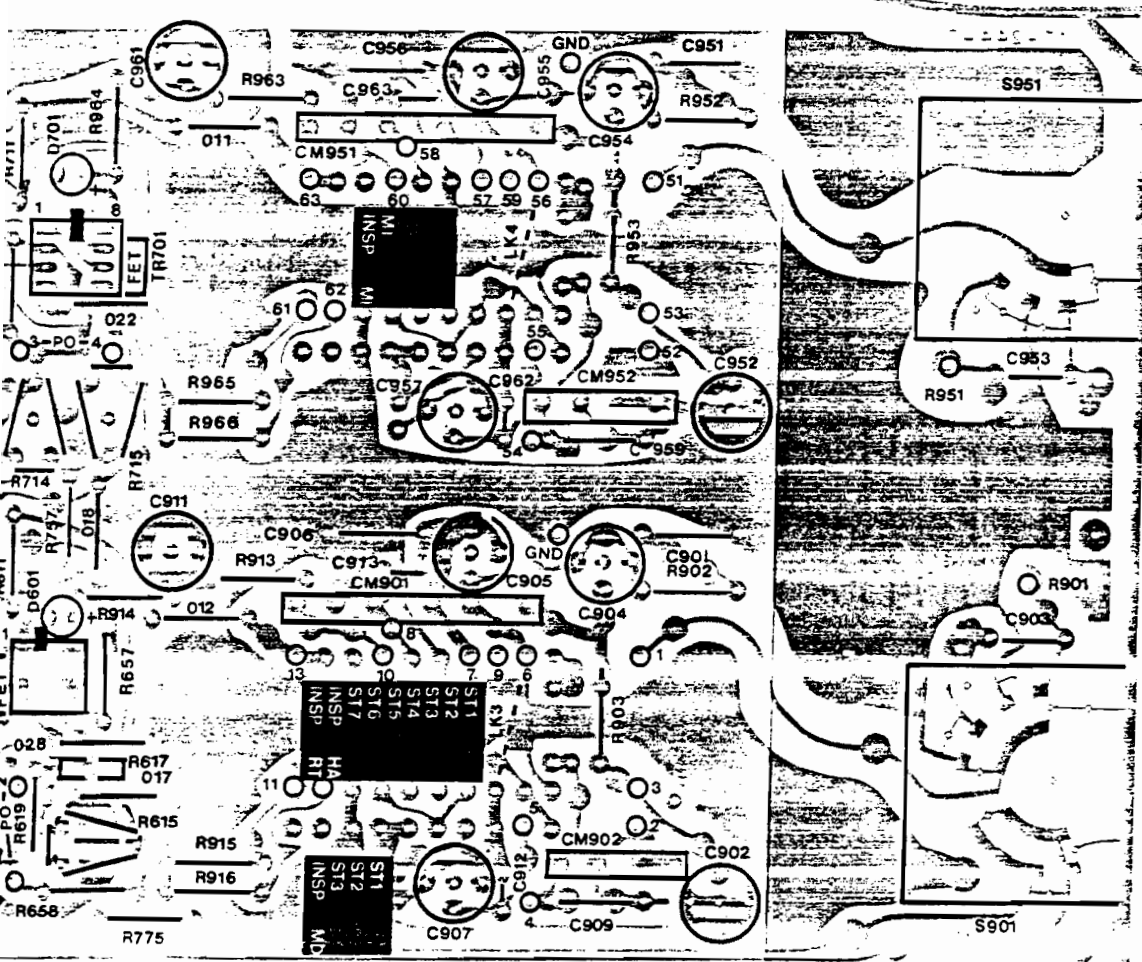
**PC 247**

D401 to D404, FS401, R413, R426, S401 to S404.

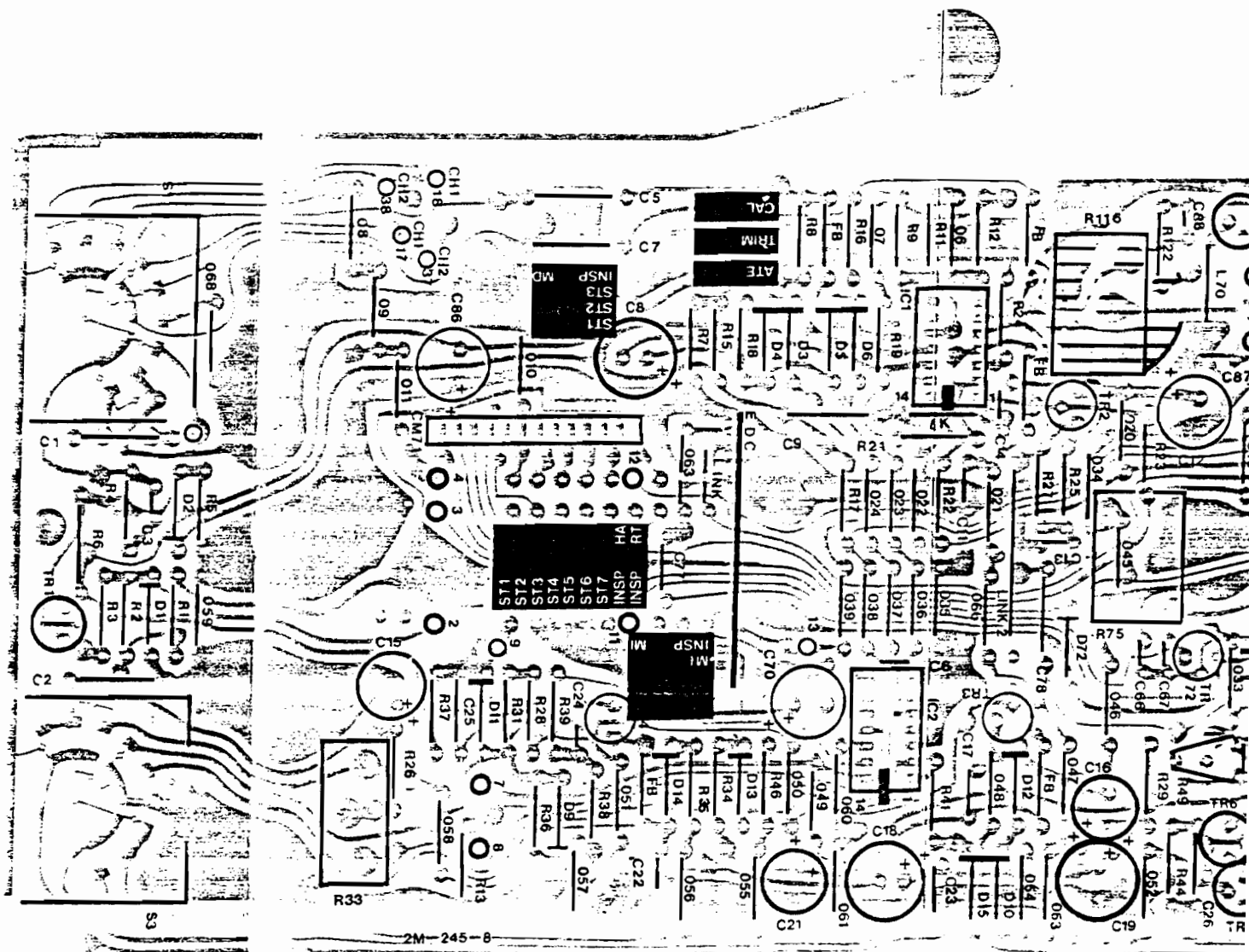


## PC 244

C601, C631, C632, C701, C702, C731, C770 to C774, C776 to C779, C800, C801, C802, CM901, C902, CM902, C903 to C907, C909, C911 to C913, C951, CM951, C952, C953 to C957, C959, C961 to C963, D601, D603, D604, D701 to D704, D770 to D776, IC601, IC602, IC701 to IC703, IC771, L800, L801, PL401, R601 to R606, R608, R609, R611, R612, R617, R619, R621 to R625, R627 to R629, R631 to R639, R641 to R649, R651 to R658, R706, R708 to R712, R714, R715, R717, R719, R721 to R725, R729 to R738, R741 to R749, R751 to R759, R761 to R769, R771 to R779, R781, R782, R784 to R799, R801 to R803, R819 to R821, R832, R833, R901, R913 to R916, R951 to R953, R963 to R966, S901, S951, TR8, TR601, TR701, TR820



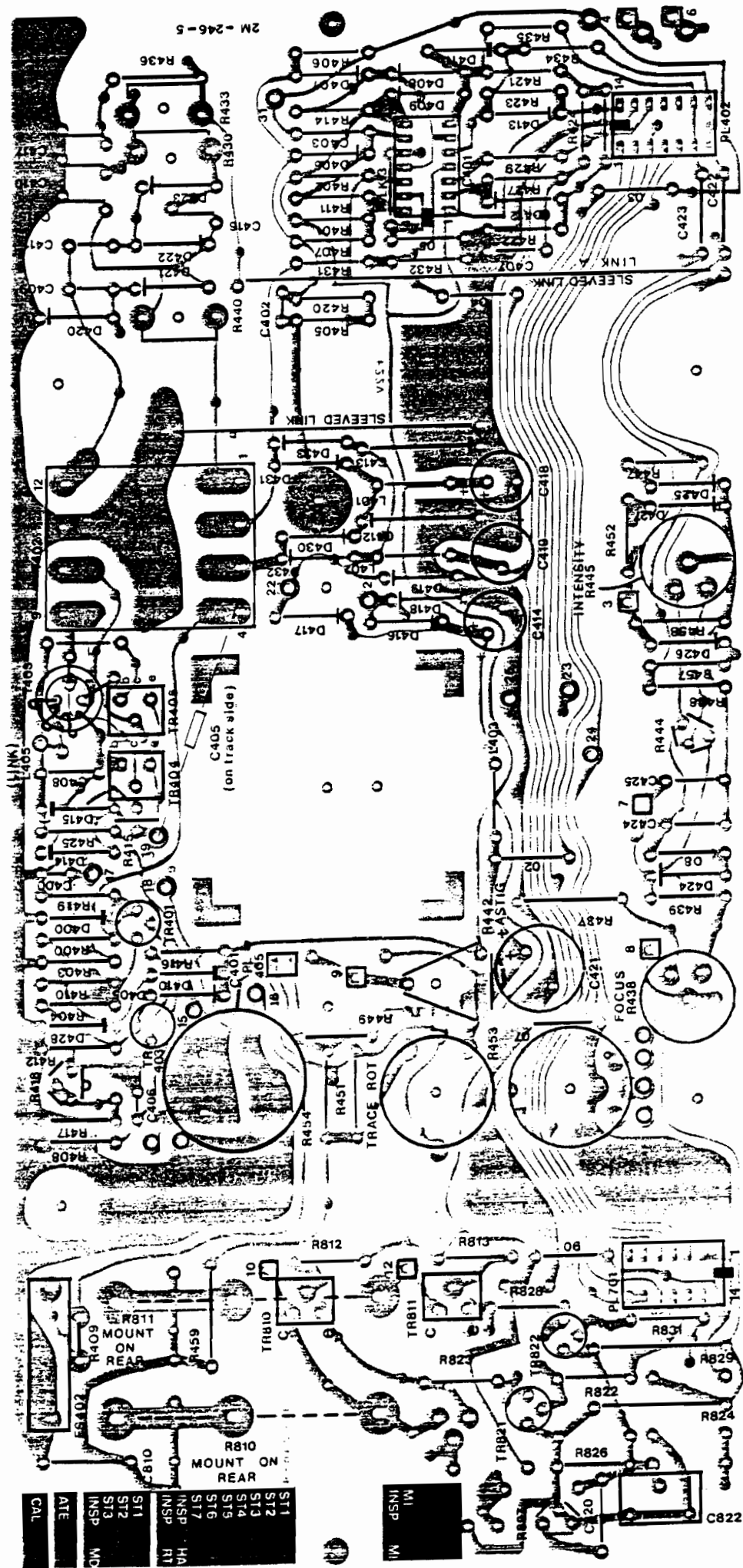
6 to C779, C800, C801, C823, C901,  
 , C951, CM951, C952, CM952, C953  
 D704, D770 to D776, IC601 to IC603,  
 R608, R609, R611, R612, R614, R615,  
 R641 to R649, R651 to R658, R701 to  
 5, R729 to R738, R741 to R758, R774  
 to R821, R832, R833, R901 to R903,  
 TR8, TR601, TR701, TR820, TR823.



## PC 245

C1 to C5, C7 to C9, C11 to C19, C21 to C27, C67 to C69, C71 to C74, C7 C86, C87, C89, C91 to C96, D1 to D6, D8 to D17, D70 to D81, D84 to D8 IC4, L71 to L73, L75, L76, PL402, R1 to R13, R15 to R19, R21 to R31, R3 R51, R52, R69 to R83, R95 to R112, R116, R118, R120, R123 to R129, R R145, S1, S3, TR1, TR2, TR4 to TR6, TR71 to TR79, TR81.





### PC 246

C400 to C403, C405 to C419, C421 to C425, C810, C820, C822, D400, D405 to D428, D430 to D433, IC401, L401 to L403, PL401, PL402, PL404, R400 to R403, R405 to R412, R414 to R418, R421 to R425, R427, R429 to R440, R444, R445, R447 to R449, R451 to R454, R457 to R459, R810 to R813, R822, R824, R826 to R829, R831, TR403 to TR405, TR810, TR811, TR821, TR822, T402, T403.

CA1	ATE
IC401	INS
IC402	INS
IC403	INS
IC404	INS
IC405	INS
IC406	INS
IC407	INS
IC408	INS
IC409	INS
IC410	INS
IC411	INS
IC412	INS
IC413	INS
IC414	INS
IC415	INS
IC416	INS
IC417	INS
IC418	INS
IC419	INS
IC420	INS
IC421	INS
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IC431	INS
IC432	INS
IC433	INS
IC434	INS
IC435	INS
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IC489	INS
IC490	INS
IC491	INS
IC492	INS
IC493	INS
IC494	INS
IC495	INS
IC496	INS
IC497	INS
IC498	INS
IC499	INS
IC500	INS

M1	INS
M2	INS
M3	INS
M4	INS
M5	INS
M6	INS
M7	INS
M8	INS
M9	INS
M10	INS
M11	INS
M12	INS
M13	INS
M14	INS
M15	INS
M16	INS
M17	INS
M18	INS
M19	INS
M20	INS
M21	INS
M22	INS
M23	INS
M24	INS
M25	INS
M26	INS
M27	INS
M28	INS
M29	INS
M30	INS
M31	INS
M32	INS
M33	INS
M34	INS
M35	INS
M36	INS
M37	INS
M38	INS
M39	INS
M40	INS



# SECTION 6

## MECHANICAL PARTS

### 6.1 INTRODUCTION

The Mechanical Parts shown on the Parts List are referenced on the Exploded Views 1 and 2 as item numbers, where they can be identified for replacement purposes. The Exploded Views clarify the dismantling and re-assembly procedures stated under Maintenance and Fault-finding Section 7. The views shown apply to both instruments and the differences appear on the Parts List.

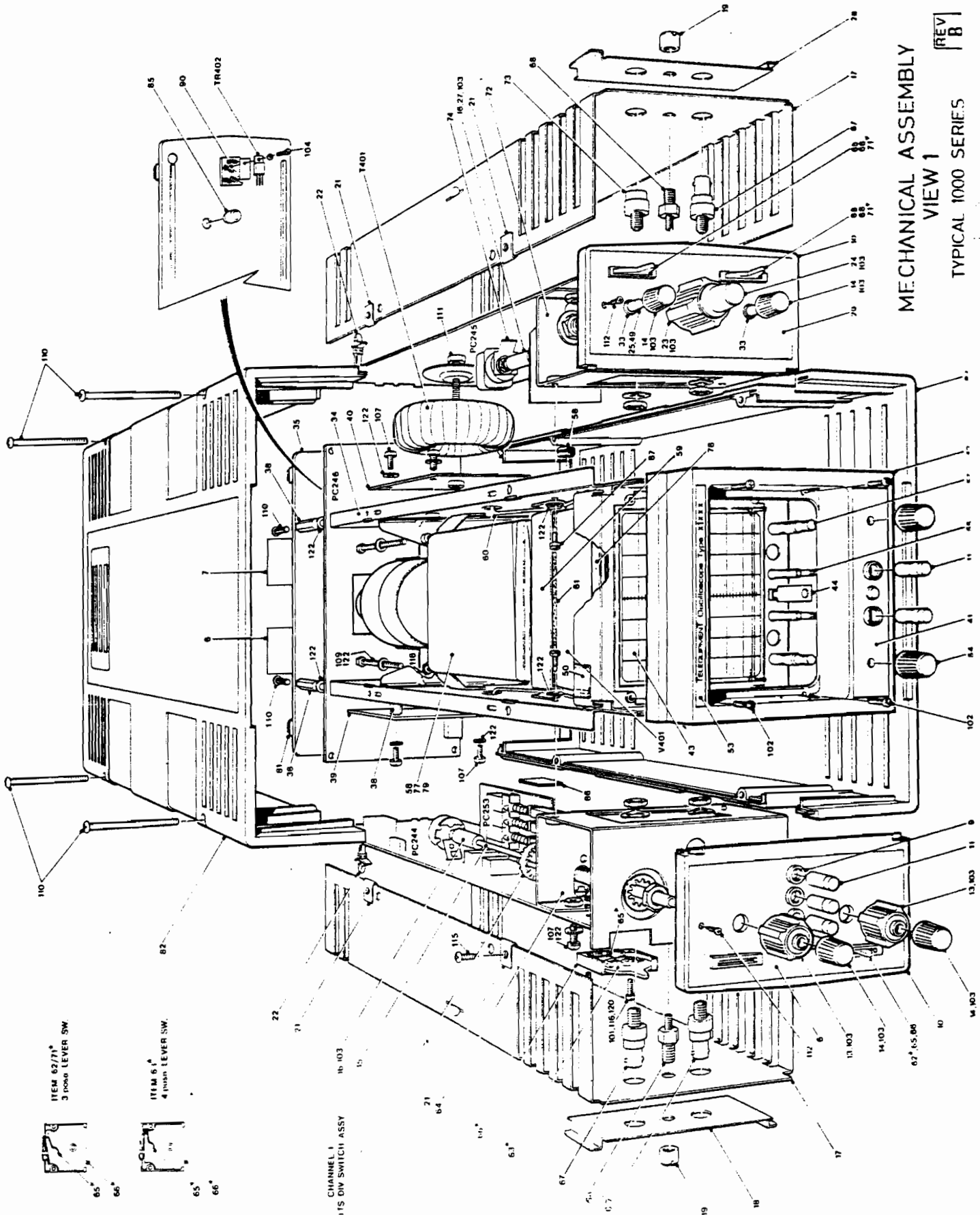
The legends on the front panels are shown on the photograph at the front of this manual.

### 6-2 PARTS LIST

Item	Part No.	Description	Starting Ser. No.	Item	Part No.	Description	Starting Ser. No.
1	348-0603-00	Foot L/H		54	366-1239-02	Knob Assembly	
2	348-0604-00	Foot R/H		55	384-1535-00	Shaft, Extension 267,5mm	
3	348-0605-00	Flipstand, Cabinet		56	376-0191-00	Coupling	
4	344-0320-00	Clip, Power Cord		57	334-1536-00	Shaft, Extension Assy	
5	334-3541-00	Marker Ident Ser No.			366-1407-02		
6	333-2541-03	Panel, Rear L/H	738501	58	348-0162-00	Grommet	
7	333-2542-03	Panel, Rear R/H	738501	61	252-0707-00	Self Adhesive Foam	
△ 8	333-2544-03	Panel, Front Vert Amp	741251	62	401-0450-01	Rotor Assembly	738501
□ 9	333-2546-03	Panel, Front Vert Amp	741651	63	401-0450-01	Rotor Assembly	738951
△ 9	200-1885-00	Bezel, Push-Button		64	407-2243-00	Bracket, BNC	741051
10	386-4150-01	Sub-Panel Moulding	741251	65	214-2892-00	Spring Detent	
11	366-1788-00	Push Button		66	380-0580-00	Housing	
12	384-1535-01	Shaft, Extension 185mm		67	131-2268-00	Connector, BNC Assy	
13	366-1387-00	Knob Assembly		68	355-0529-00	Post, Earthing	
14	366-1535-00	Knob Assembly		69	337-2630-00	Screen, Input Socket	
15	384-1142-21	Shaft Extension 238mm		70	352-0474-00	Fuseholder 5mm x 20mm	738501
16	376-0126-00	Coupling Flexible ¼" - ½"		71	401-0450-01	Rotor Assembly	738501
17	337-2625-01	Shield, Electrical		72	407-2311-01	Bracket, BNC	741251
18	386-4151-01	Panel, BNC 'Y'		73	131-2275-00	Connector, (CAL) Assy	
19	220-0840-00	Ring Nut		74	407-2332-00	Bracket, Pot Mounting	
20	131-2341-00	Spring, Earthing		75	337-2631-00	Shield, Electrical-Atten.	
21	220-0845-01	Nut, Spire					
22	386-4152-00	PCB Support		77	337-2627-00	Shield, CRT	
□ 23	366-1241-01	Knob Assembly		78	348-0621-00	Shockmount, CRT	761201
△ 24	366-1241-00	Knob Assembly		79	343-0812-00	Collar, Clamping CRT	
△ 24	366-1238-00	Knob Assembly		80	348-0620-00	Foot, Cabinet	
25	384-1142-22	Shaft, Extension 38mm		81	348-0620-00	Foot, Cabinet - Heatsink	
26	384-1142-23	Shaft, Extension 13.5mm		82	—	Cabinet, Top Assembly	
27	384-1142-24	Shaft, Extension 168mm		83	—	Cabinet, Bottom Assembly	
28	333-2554-00	Panel, BNC 'X'		84	358-0611-01	Cable Cleat	
□ 29	333-2543-04	Panel, Front Timebase	741651	85	358-0611-01	Bush - Z MOD Skt	741251
△ 30	333-2543-05	Panel, Front Timebase	741251	86	386-4194-00	PCB Guide	
30	386-4153-01	Sub Panel Moulding	741251	87	213-0822-00	Screw, Special	
32	131-2342-00	Spring, Earthing		88	343-0805-00	Cable, Clamp	
33	358-0609-00	Bush		89	210-0297-02	Tag, Earthing	
34	—	Chassis Assembly		90	006-2915-00	A30/J Compound	
35	214-2904-04	Heat Sink, Rear		91	161-0124-00	Power Cord	
36	343-0815-00	Clamp, Power Cord					
37	358-0610-00	Grommet, Power Cord		100	213-084-01	Screw, M2 x 6mm Pan	
38	129-0768-00	Spacer		101	213-0831-00	Screw, M2 x 10mm Pan	
39	214-2898-00	Heatsink, Transistors		102	213-0837-00	Screw, M2.5 x 5mm Pan Blk	
40	407-2318-00	Bracket, Transformer Mtg		103	213-0248-00	Screw, M3 x 3 Hex Skt Drive	
41	333-2545-01	Panel, Front Control		104	213-0832-00	Screw, M3 x 8mm Pan	
42	200-2352-00	Bezel		105	213-0833-00	Screw, M3 x 8mm Ch Slot	
43	331-0547-01	Graticule Blue		106	213-0834-00	Screw, M3 x 10mm Pan	
44	352-0554-00	Holder, LED		107	213-0825-00	Screw, M4 x 8mm Pan	
45	367-0270-00	Handle Assembly		108	213-0835-00	Screw, M4 x 12mm Pan Blk	
46	367-0271-00	Grip, Handle		109	213-0836-00	Screw, M4 x 30mm Pan	
47	101-0049-00	Trim, Handle		110	213-0826-00	Screw, M4 x 80mm Pan Blk	
48	344-0323-00	Clip, Retaining		111	213-0830-00	Screw, M6 x 40mm Hex	
49	376-0126-00	Flexible Coupling		112	213-0847-00	Screw, S/T No. 2 x ¼" Blk	741251
50	334-2752-00	Label (Mod Record)		113	213-0829-01	Screw, S/T No. 4 x ¼"	
51	381-0411-00	Bar, Support		114	213-0827-01	Screw, S/T No. 5 x 1"	
52	200-2359-02	Cover, Voltage Selector		115	213-0828-01	Screw, S/T No. 8 x ½"	741051
□ 53	334-3554-03	Nameplate		116	220-0846-00	Nut M2	
△	334-3554-01	Nameplate		117	220-0847-00	Nut M3	
				118	220-0848-00	Nut M4	
				120	210-1313-00	Washer, M2 Crinkle	
				121	210-1314-00	Washer, M3 Crinkle	
				122	210-1311-00	Washer, M4 Crinkle	
				123	210-1079-00	Washer, ¾" Shakeproof	
				124	210-1310-00	Washer, M6 Crinkle	
				125	—	Washer, HT Transfer	

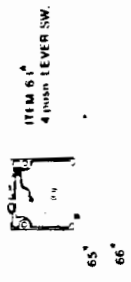
□ denotes used on D1010 only

△ denotes used on D1011 only



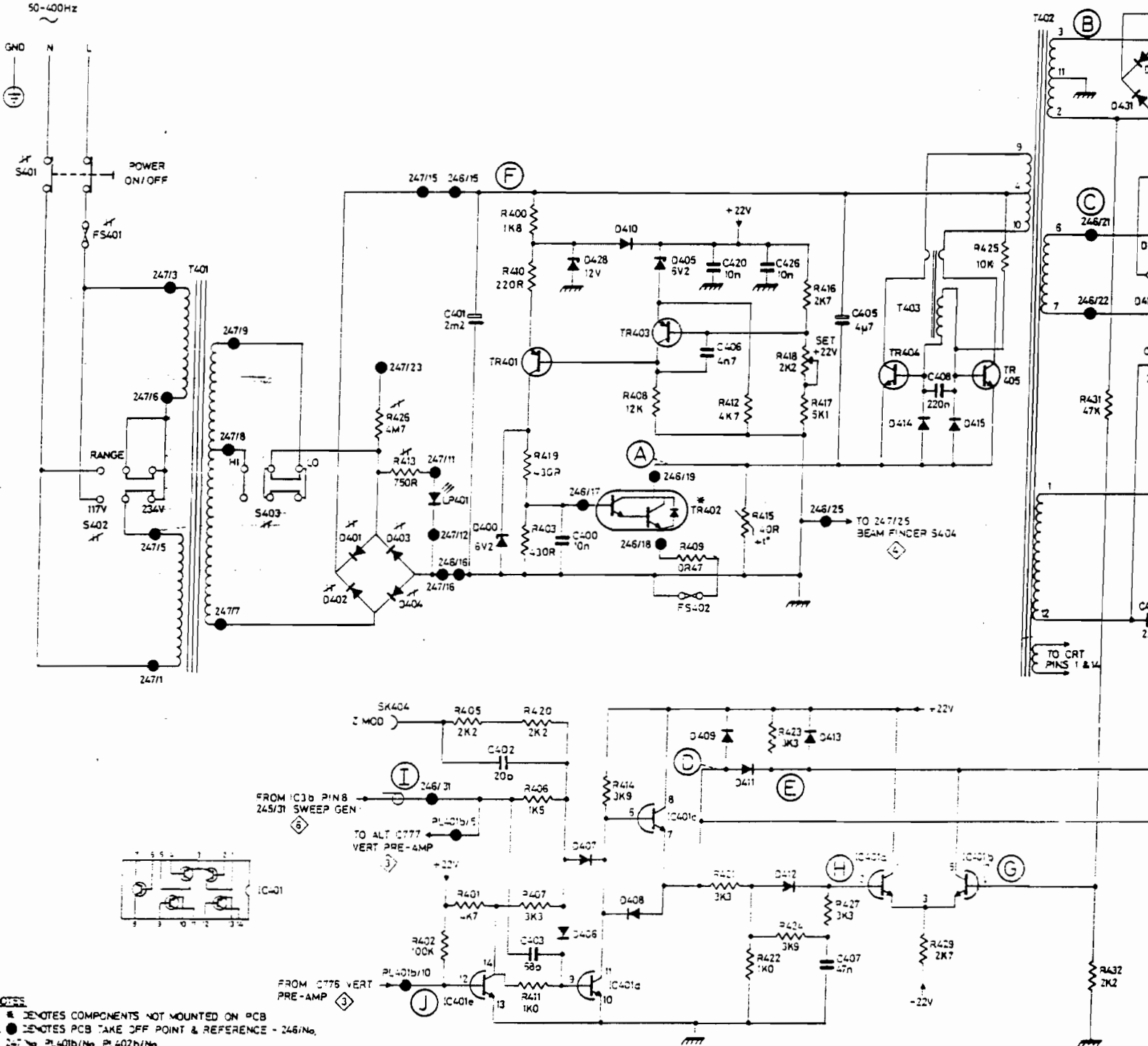
MECHANICAL ASSEMBLY  
 VIEW 1  
 TYPICAL 1000 SERIES

REV B



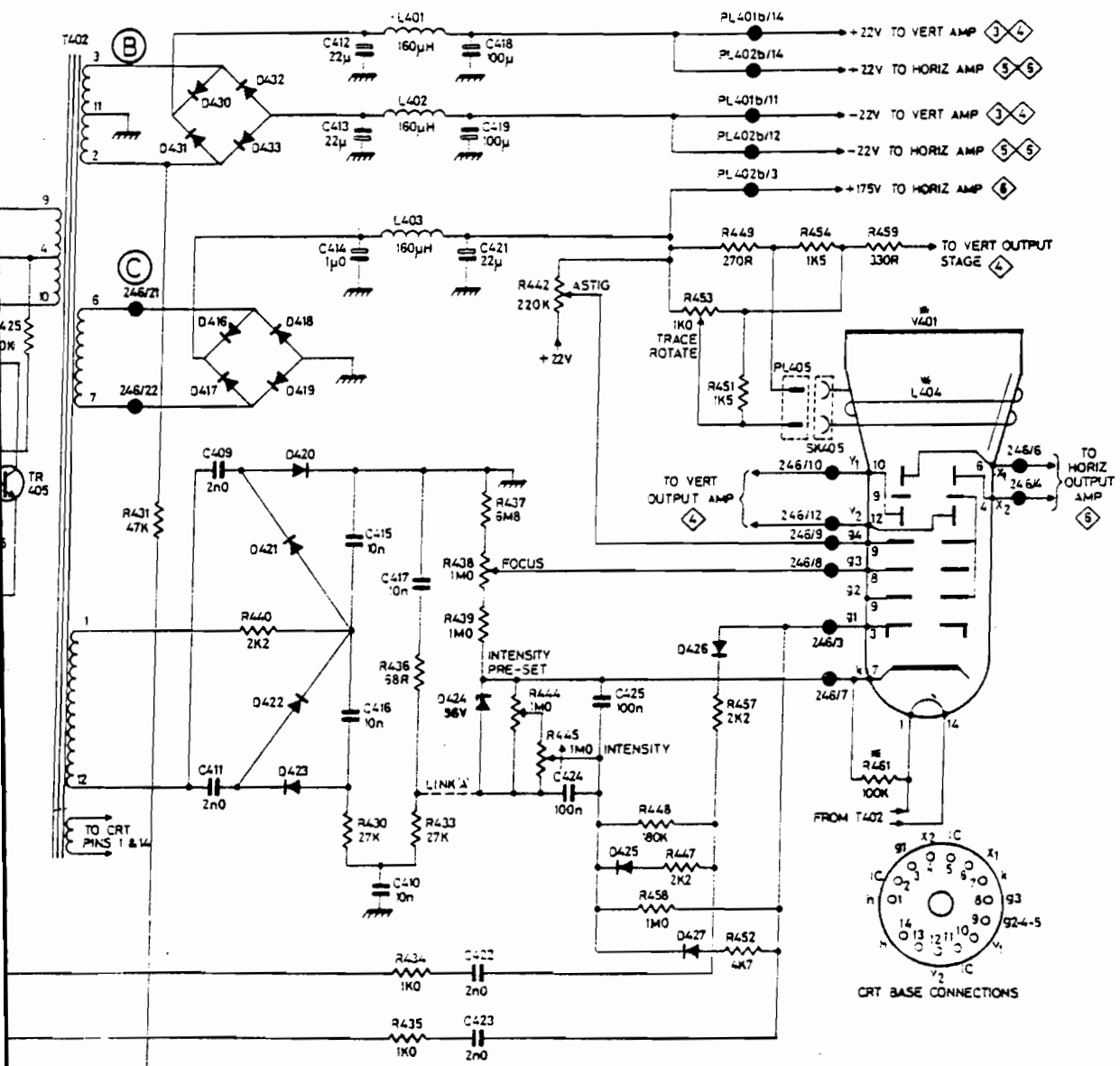
CHANNEL 1  
10115 DIV SWITCH ASSY

RESISTORS	426	413	401	400	420	414	408	412	423	416	427	429	425	431	432						
			402	40	406			409	422	418	417										
			405	-19	411				421	424											
CAPACITORS			401	402	403	400		406	426		407	408									
								420													
MISC.	FS401	S402	T401	S403	D401	D403	LP401	D400	TR401	D406	D408	TR402	FS402	D411	D413	TR404	T403	IC401b	D43	D43	
	S401				D402	D404	SK404	IC401e	D407	D410	TR403	D405	D409	D412	D413	IC401a	D414	D415	TR405	D43	D43
PCB246	●						15	16		17	18			25						21	22
PCB247	●	5	3	7	8	23	15	12	16		19										

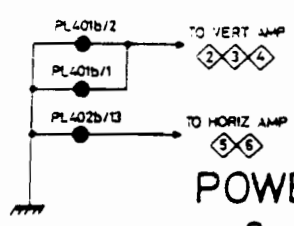


- NOTES**
- DENOTES COMPONENTS NOT MOUNTED ON PCB
  - DENOTES PCB TAKE OFF POINT & REFERENCE - 246/No.
  - PL401b/No, PL402b/No.
  - S401 TO 4, S401 TO 3, FS401, R413 & R426 ARE MOUNTED ON PCB247.
  - REFER TO (A) FOR INTERCONNECTION ROUTES.

425	431	430	436	437	442	448	449	454	459
	432		433	438		458	451		461
			434	439	445	457	455		
			435			453		452	
					444				
					424	425			
409	412	410	417	418					
411	413	415	419	422					
	414	416	421	423					
0430	0416	0432	0418	0421	L401	0425	0426	PL405	V401
TR405	0431	0417	0433	0419	L402	0427	0427	SK405	L404
T402			0420	0423	L403				
21	PL401b/2	PL402b/13				PL401b/14	PL401b/11	9	10
22	PL401b/1					PL402b/14	PL402b/12	8	12
							PL402b/3	3	12
									6
									4



7 D1010-D1011  
**POWER SUPPLY - CRT  
& BLANKING**



### POWER SUPPLY BLANKING AND CRT (Diagram 7)

The Power Supply provides the instrument with smoothed regulated supplies of +22V d.c., -22V d.c., +170V d.c., -1800V d.c. and 6.3V for the CRT heater. The supply is fed from a toroidal line transformer T401. S401 is the front panel ON-OFF switch and fuse FS401 protects against malfunction at line voltages. S402 selects 234 or 117 volt operation, while S403 has HI-LO positions for high and low mains respectively.

The secondary of T401 charges reservoir capacitor C401 through bridge rectifier D401, 2, 3, 4.

The tapping from rectifiers D401 and D403 supplies current to the front panel LED indicator. Inverter transformer T402 operating at approximately 20kHz provides the requisite d.c. supplies and CRT heater voltage. The primary of the inverter is driven by power transistors TR404 and TR405, the current feedback being provided by toroidal transformer T403 through which the collector currents of the power transistors pass in antiphase. A positive feedback 4 turn base to base winding produces a 4 : 1 current step down to enable oscillation. This winding is in series with diodes D414 and D415 which 'catch' negatively, thus forcing the other end of the winding to drive the current into the base of the power transistors.

R425 is the starting resistor. The positive feedback winding of T403, together with C408, maintains the correct frequency of oscillation.

The current to the inverter circuit is supplied by a Power Darlington transistor TR402, which dissipates heat through the rear heatsink of the instrument. This constant current is generated in the loop consisting of TR402, emitter resistor R409 and fuse FS402, and transistors TR401 and TR403 with reference zener diode D405.

The +22V d.c. supply from the rectified output of the inverter is compared to the zener reference in the resistor chain R416, trimming pot R418 and resistor and the loop adjusts the current to the inverter circuitry to ensure correct operation.

At the positive terminal of reservoir capacitor C401 there is, approximately, a mean d.c. potential of 29V with a ripple content at twice line frequency of 4V peak to peak. Zener diode D428 smoothes this voltage to avoid injecting ripple into the loop in series with the regulating circuit, as this would appear on all d.c. supply lines. The 4V peak to peak ripple which exists at the centre top of the inverter transformer also exists at the output of the constant current regulator loop, and the collector of TR409, hence the resultant voltage across the inverter transistors is smoothed d.c. R418 adjusts the output of all the supply lines but is referenced to the +22V supply. Posistor (+ve temperature coefficient resistor) R415 when cold has a value of approximately 40Ω and provides start-up current for the loop. In operation, its resistance and temperature rise so that it does not pass significant current rise in parallel with TR402.

Protection against failure of the supply is threefold:

- (i) Short term, i.e. a momentary short circuit of any supply line, is absorbed by the constant current feed to the inverter; current is limited and so are fault currents.
- (ii) A permanent fault whilst the instrument is operating will result in a heavy current demand from the supply. The supply current, however, is limited by catching zener diode D400, R419, and R403, thus limiting the voltage to the base of TR402, with resistor R409 regulating the current to a value that will blow the fuse FS402 if the fault doesn't clear in approximately 30 seconds.

(iii) A fault such as (ii) existing at switch on, especially at the +22V line which supplies most of the circuitry of the instrument, will pass current through D410 and prevent voltages from rising around the regulator loop. In particular, emitter current through TR401 will be severely limited therefore the Darlington transistor TR402 will not be energised. This will prevent further damage being caused by the inverter turning on.

### BLANKING AND INTENSITY CONTROL

This circuitry is built around a 5 transistor array IC401, and the resistors and diodes around the grid-cathode path of the CRT.

(i) If IC401 were removed or inactivated, the brightness of the trace would be set by the INTENSITY control, R445, through 10M resistor R458.

(ii) with no signal to the instrument and the time base stopped, IC401 sits as follows:

- (a) Collector pin 14 bottomed because of bias through R402.
- (b) Collector pin 11 low, because of bias through R401, etc., from the +22V line. Diode D406 and D407 ensure that collector pin 11 does not saturate, by diverting excess base current into the collector (pin 11).
- (c) This keeps the output of emitter follower (IC401c) pin 7 low.
- (d) The base, (pin 2) of IC401a is at 0 volts, through base resistance return paths, as long as (c) is low.
- (e) Approximately 2V peak to peak of inverter waveform is fed to pin 4, (base) of IC401b through R431 and R432.

This switches the transistor on-off at inverter frequency. When on, it bottoms at about 0V. This is the CRT blanking condition, because the 22V signal across R423 is d.c. restored in C423 and diode D427, maintaining the grid of the CRT at about 20V more negative than the INTENSITY control setting.

- (f) When the time base is triggered, a -ve pulse is fed to terminal 246/31 cutting off IC401d and allowing emitter follower IC401c to rise rapidly. (Note that a -ve signal into the external Z mode terminal would have the same effect). The rapid rise of voltage towards the +22V line at pin 7 as described has two effects: firstly it is coupled directly through to the grid of the CRT via C423 and unblanks; secondly it is coupled after some small delay as a +ve step to the base of IC401a, cutting IC401b off and stopping the latter from reproducing the inverter frequency across R423. In any case, diode D411 holds R423 high and the CRT stays unblanked.
- (g) If the Time Base is operating at 1ms/div or slower the instrument is in the CHOP mode when set to dual channel display. Negative chop blanking pulses from the chop oscillator are fed to the base of IC401e, pin 12, cutting off the transistor and bottoming briefly IC401d which blanks the tube to mask the chop transition between traces.
- (h) At the end of the Time Base stroke pin 31 goes high and cuts off IC401d. The drop in voltage at the emitter (pin 7) of IC401 is assisted to retain speed by direct pull-down by IC401d through diode D408, and the CRT is cut off. Simultaneously, transistor IC401b is allowed to generate a squarewave at inverter frequency across R423. This signal is d.c. restored as in (e) and maintains the grid of the CRT in the cut-off condition, until the next triggering of the time base.

CIRCUIT

CCT P  
REF N

C400 2

C401 2

C402 2

C403 2

C405 2

C406 2

C407 2

C408 2

C409 2

C410 2

C411 2

C412 2

C413 2

C414 2

CCT PA

REF NU

D400 152

D401 152

D402 152

D403 152

D404 152

D405 152

D406 152

D407 152

D408 152

D409 152

D410 152

D411 152

D412 152

D413 152

D414 152

D415 152

D416 152

D417 152

D418 152

D419 152

D420 152

D421 152

D422 152

D423 152

D424 152

D425 152

D426 152

D427 152

D428 152

D430 152

D431 152

D432 152

D433 152

FS401 159

FS401 159

IC401 156

CIRCUIT 7 ELECTRICAL PARTS LIST

CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.	CCT REF	PART NUMBER	VALUE F	TYPE	TOL %	RATING V	Starting Ser. No.
C400	281-0710-00	10 n	CER	+80 -20	250		C415	281-0677-00	10 n	CER	+80 -20	2k0	
C401	290-0624-01	2m2	ELEC	+100 -10	40		C416	281-0677-00	10 n	CER	+80 -20	2k0	
C402	285-0867-00	20 p	PS	1 p	350		C417	281-0677-00	10 n	CER	+80 -20	2k0	
C403	285-0845-00	68 p	PS	2 p	350		C418	290-0784-00	100 μ	ELEC	+100 -10	25	742051
C405	290-0635-00	4μ7	ELEC	+100 -10	63	742301	C419	290-0784-00	100 μ	ELEC	+100 -10	25	742051
C406	281-0822-00	4n7	CER	20	50	738501	C420	281-0710-00	10 n	CER	+80 -20	250	742301
C407	285-0836-00	47 n	PE	20	250		C421	290-0837-00	22 μ	ELEC	+50 -10	250	
C408	285-1182-00	220 n	PE	20	100		C422	281-0779-00	2n0	CER	+70 -20	2k0	
C409	281-0779-00	2n0	CER	+70 -20	2k0		C423	281-0779-00	2n0	CER	+70 -20	2k0	
C410	281-0677-00	10 n	CER	+80 -20	2k0		C424	285-0915-00	100 n	PE	20	100	
C411	281-0779-00	2n0	CER	+70 -20	2k0		C425	285-0915-00	100 n	PE	20	100	
C412	290-0556-00	22 μ	ELEC	+100 -10	25		C426	281-0710-00	10 n	CER	+80 -20	250	742301
C413	290-0556-00	22 μ	ELEC	+100 -10	25								
C414	290-0835-00	1μ0	ELEC	+75 -10	250								

CCT REF	PART NUMBER	VALUE V	DESCRIPTION	RATING	Starting Ser. No.	CCT REF	PART NUMBER	VALUE	DESCRIPTION	Starting Ser. No.		
D400	152-0348-00	6V2	Zener BZY88C	400 mW	738501	L401	108-0932-00	160μH	Fixed Inductor			
D401	152-0707-00	50	GP20A			L402	108-0932-00	160μH	Fixed Inductor			
D402	152-0707-00	50	GP20A			L403	108-0932-00	160μH	Fixed Inductor			
D403	152-0707-00	50	GP20A			L404			Coil. TRACE ROTATE. Supplied with CRT			
D404	152-0707-00	50	GP20A									
D405	152-0348-00	6V2	Zener BZY88C	400 mW						742301		
D406	152-0062-01	75	IN914/IN4148	50 mA								
D407	152-0062-01	75	IN914/IN4148	50 mA								
D408	152-0062-01	75	IN914/IN4148	50 mA								
D409	152-0062-01	75	IN914/IN4148	50 mA								
D410	152-0062-01	75	IN914/IN4148	50 mA		LP401	150-1072-00		LED FLV150 Red POWER ON	764751		
D411	152-0062-01	75	IN914/IN4148	50 mA								
D412	152-0062-01	75	IN914/IN4148	50 mA								
D413	152-0062-01	75	IN914/IN4148	50 mA								
D414	152-0737-00	150	BYX36									
D415	152-0737-00	150	BYX36									
D416	152-0708-00	200	BA157			PL401b	175-2216-00 (part of)		Connector Male 14 pin			
D417	152-0708-00	200	BA157			PL402b	175-2216-00 (part of)		Connector 14 pin			
D418	152-0708-00	200	BA157			PL405			Connector 2 pin. Mounted on PC246			
D419	152-0708-00	200	BA157									
D420	152-0352-00	800/1k0	GP10M (G.I.)									
D421	152-0352-00	800/1k0	GP10M (G.I.)									
D422	152-0352-00	800/1k0	GP10M (G.I.)									
D423	152-0352-00	800/1k0	GP10M (G.I.)									
D424	152-0726-00	56	Zener BZX79	400 mW	742301							
D425	152-0352-00	800/1k0	GP10M (G.I.)									
D426	152-0062-01	75	IN914/IN4148	50 mA								
D427	152-0554-00	50	BAY74									
D428	152-0545-00	10	Zener BZY88C10	400 mW	738501	R400	317-0182-01	1k8	CF	5	125 m	738501
D430	152-0709-00	50	RGP10A (G.I.)			R401	317-0472-01	4k7	CF	5	125 m	
D431	152-0709-00	50	RGP10A			R402	317-0104-01	100 k	CF	5	125 m	
D432	152-0709-00	50	RGP10A			R403	317-0431-01	430R	CF	5	125 m	738501
D433	152-0709-00	50	RGP10A									
FS401	159-0167-00	400 mA	Fuse 5 x 20mm DLY (234V)			R405	317-0222-01	2k2	CF	5	125 m	738661
FS401	159-0168-00	800 mA	Fuse 5 x 20mm DLY (117V)		752951	R406	317-0152-01	1k5	CF	5	125 m	
IC401	156-0197-02		Transistor Array PCA 3086			R407	317-0332-01	3k3	CF	5	125 m	
						R408	317-0123-01	12k	CF	5	125 m	738501
						R409	308-0805-00	0R47	WW	10	1 W	
						R410	317-0221-01	220 k	CF	5	125 m	738501
						R411	317-0102-01	1k0	CF	5	125 m	
						R412	317-0472-01	4k7	CF	5	125 m	738501
						R413	303-0751-01	750 R	CF	5	1	
						R414	317-0392-01	3k9	CF	5	125 m	
						R415	307-0647-00	40 R	PTC	±15 R	25°C	
						R416	317-0272-01	2k7	CF	5	125 m	
						R417	317-0512-01	5k1	CF	5	125 m	
						R418	311-2036-00	2k2	CP	20	50 m	
						R419	317-0431-01	430 R	CF	5	125 m	738501
						R420	317-0222-01	2k2	CF	5	125 m	738661

## SECTION 7

## MAINTENANCE AND FAULTFINDING

## 7.1 INTRODUCTION

This section contains information on preventive and corrective maintenance and dismantling procedures.

Exploded views of the instrument together with a mechanical component list are included to enable the parts used in the assembly to be identified.

## 7.2 PREVENTIVE MAINTENANCE

## 7.2.1 GENERAL

This is an important part of the maintenance of the instrument because if done regularly and properly, the instrument should perform more efficiently, and costly corrective maintenance could possibly be avoided.

## 7.2.2 Preventive maintenance consists of the following:-

- (a) Regular visual checks for loose parts or connections; broken connections especially on circuit boards; transistors not seated in holders correctly; signs of components overheating such as scorch marks (the reason should be investigated).
- (b) Regular removal of dust and dirt from both the exterior and the interior, particularly on electrical components.
- (c) Regular lubrication of moving components such as spindle and switch mechanisms. Rotary switch contacts can suffer from a corrosive deposit which affects their electrical performance. The correct lubricant for switch contacts, which also cleans is a mixture of 10 parts petroleum jelly and 90 parts white spirit. Lubricate and operate switches regularly to ensure that electrical continuity is maintained. Other non-electrical moving parts such as spindles in their bushes or bearings should be given a slight smear of silicon grease.

## 7.3 CORRECTIVE MAINTENANCE

## 7.3.1 GENERAL

Corrective maintenance concerns repair and component replacement. This work will require a certain amount of dismantling described in a later part of this section.

## 7.3.2 COMPONENT REPLACEMENT

The majority of the components used in the manufacture of this instrument are listed either on the Mechanical Component List or the appropriate Electrical Component List.

To order a replacement part, it is essential that the following information be given to the Tektronix Field Office or the local representative.

- (a) Instrument Type.
- (b) Serial Number.
- (c) Description and Circuit Reference for electrical components.  
or
- (d) Description and Item Number (if shown) for mechanical components.
- (e) Part Number.

For some of the standard electrical components it is possible to obtain them from a local source, provided that they are known to be direct replacements, both physically and electrically.

The majority of the electrical components are mounted on circuit boards, therefore it is essential that standard soldering techniques are used. After replacing an electrical component, it will normally be necessary to re-calibrate the instrument over that portion of the circuit affected. (refer to Section 8 Re-calibration).

**CAUTION—Replacing transistors TR810 and TR811 on PC246.** Beryllia washers are used to insulate the collector tabs of TR810 and TR811 from their heatsink. The only hazard is that a toxic effect may occur if fumes or fine particles are inhaled. Grinding, crushing or heating above 1800°F can produce fumes or fine particles. No hazard is present in normal instrument operation or maintenance.

## 7.4 DISMANTLING PROCEDURES

The following procedures provide access to various parts of the instrument to enable mechanical and electrical components replacement to be achieved as easily as possible.

A figure in a circle refers to the item number shown on the Mechanical Assembly and Component List.

Interconnection Diagram 10 shows the electrical connections between boards etc., and is useful for identifying the leads mentioned in the procedures.

Before starting to dismantle any part of the instrument, make certain that it is not connected to the line voltage supply. Re-assembly procedures are a reversal of the dismantling procedures.

## 7.4.1 TOP COVER REMOVAL

Remove the four top screws (110) and lift off the cover.

## 7.4.2 BOTTOM COVER REMOVAL

After removal of the Top Cover, remove the four screws (114) located through the feet and lift off the cover. The feet (1) (2) are retained in position by their own fixing screws (113).

## 7.4.3 VERTICAL AMPLIFIER UNIT REMOVAL

1. Remove the two screws and washers (87) (122) through the top and bottom of the chassis assembly (34) at the front end.
2. Remove the two screws (115) from the top flange of the chassis assembly securing the shield (17).
3. Support the unit and separate from the chassis to expose the track side of PC244.  
If it is necessary to completely detach this unit from the instrument, continue this procedure.
4. Disconnect the ribbon lead from the rear of PC244 via the plug PL401a and socket.
5. Unsolder the flying trigger lead from connections (17) and (18) on PC244.
6. On D1011 unsolder X-Y lead from connections (26) and (27) on PC244.

**7.4.4 ELECTRICAL SHIELD (VERTICAL UNIT) REMOVAL**

1. Remove ring nut (19) located between CH1 and CH2 input sockets.
2. At the rear end compress the two plastic lugs (22) and carefully lift off the shield to expose the interior of the unit.

**7.4.5 HORIZONTAL AMPLIFIER UNIT REMOVAL**

1. } Similar to 7.4.3.
2. }
3. Support the unit and separate from the chassis to expose the track side of PC245. If it is necessary to completely detach this unit from the instrument continue this procedure.
4. Disconnect the ribbon lead from the rear of PC245 via the plug PL402a and socket.
5. Unsolder the flying trigger twin lead from connections (17) and (18) on PC245.
6. Unsolder coaxial lead from connections (30) and (31) on PC245.
7. Unsolder twin lead from connections (34) and (36).
8. On D1011 unsolder X-Y twin lead from connections (26) and (27) on PC245.

**7.4.6 ELECTRICAL SHIELD (HORIZONTAL UNIT) REMOVAL.**

1. Remove the ring nut (19) located between the CAL socket and the TRIG or EXT X INPUT socket.
2. At the rear end compress the two plastic lugs (22) and carefully lift off the shield to expose the interior of the unit.

**7.4.7 HEATSINK REAR PANEL REMOVAL**

1. Remove four screws (110) and gently pull the panel away from spacers (38) to expose PC246.
2. Remove the two screws and washers (106) (121) securing the power cord clamp (36).
3. Disconnect the leads to the power transistor TR402 by gently pulling off the socket.

**7.4.8 POWER SUPPLY BOARD PC246 REMOVAL**

1. Unscrew and remove the four hexagon spacers and washers (38) (122).
2. Loosen the set screws (103) in the rear of the FOCUS and INTENSITY shaft couplings (56).
3. Slide the power cord grommet (37) from the open-ended slot in PC246.
4. Disconnect the TRACE ROTATE leads from PC247 via plug PL405.
5. Unsolder the remaining leads as shown on the Interconnection Diagram 10.
6. The board is now completely detached from the instrument.

**7.4.9 CRT REMOVAL**

1. Pull off the CRT base.
2. Disconnect the TRACE ROTATE coil leads on PC246 via plug PL401.
3. On the top side of the CRT, disengage the clamp spring arms (90) from the chassis sides.
4. Lift off the clamp (59).
5. Remove the two screws and washers (109) (122) securing the neck clamp to the chassis. Holes in PC246 allow access to the screw heads.
6. The CRT complete with mu-metal shield can now be lifted out of the chassis.
7. Remove the mu-metal screen by unwrapping the insulating tape and withdrawing the CRT.

**7.4.10 MAINS BOARD PC247 REMOVAL**

This board contains line voltage adjustment switches and fuses.

1. Remove the pressbahn cover.
2. Remove the rear screw (113).
3. Remove the two screws (113) located on either side of the two plastic shaft extensions (55) for BEAM FINDER and POWER ON/OFF.

4. Lift the board gently so that the shaft extensions disengage from their respective switches. Note that the movement is restricted by the group of wires soldered to the board. Refer to Interconnection Diagram 10 if the board is to be completely removed from the instrument.

**7.4.11 FRONT BEZEL REMOVAL**

1. Remove FOCUS and INTENSITY knobs (54) after loosening their set screws.
2. Remove four screws (102) located in the corners of the bezel (42).
3. Pull handle out straight and lift off bezel.

**7.4.12 HANDLE REMOVAL**

1. Remove the bezel.
2. Remove the retaining clips and washers (48) (124) securing the handle ends.
3. Spring out the handle side arms and lift clear of the instrument.

**7.5 POWER SUPPLY FAULT-FINDING AND REPAIR**

The power supply circuitry has been specifically designed for these instruments, therefore the following information is required to facilitate fault diagnosis.

**7.5.1 EQUIPMENT**

Dual beam monitor oscilloscope  
D.M.M./Multimeter with a sensitivity of 20k $\Omega$ /volt  
Variac/Variable a.c. power supply with 4-6 $\Omega$  resistor. 25W or  
External power supply output of 27V d.c. at 2A, with current limiting facility at approximately 1.5A.  
Ohmmeter

**7.5.2 SUPPLY NOT OPERATING**

- (a) Non-operation of the power supply clearly implies a faulty component either in the inverter circuitry or the voltage regulating loop around transistors TR401-402-403. Should any of the transistors be low resistance — because of a short circuit or high temperature, then it is likely that fuse FS402 will have blown, as well as one or both of the inverter transistors TR404-405. The remaining components in this part of the power supply are less likely to suffer damage except for resistor R400 which will be overloaded if pulled low by diode D410 and a low or zero +22V rail.
- (b) If the faulty component(s) causing non-operation are on the output side of inverter transformer T402, then the supply may not be operating because it has been 'snut-off' by a low +22V rail as mentioned previously. This situation in turn could be due to faulty rectifiers or storage and filter capacitors on the Power Supply board (PC246), or to a fault on Y AMP board (PC244) or X AMP board (PC245). Removal of the connecting plug to these boards one at a time should indicate whether the fault lies outside the Power Supply itself. In particular Ohmmeter measurements on the pins carrying the rails to the Y and X boards should be made, to avoid re-damaging the power supply after fault-finding.

**7.5.3 SUPPLY MALFUNCTIONING**

If the power supply is producing some output but not establishing the correct rail potentials, then a partial failure of the components referred to in 7.5.2 is likely to be the case.



## 7.5.3.1 FAULT FINDING PROCEDURE

- (a) The three way connector to the Darlington transistor TR402 should be disconnected. In its place between the collector and emitter terminals, the 25W 4-6 $\Omega$  resistor is connected by running leads off the power supply, to provide a semi-constant current feed to the inverter.
- (b) After identifying and replacing the faulty component(s) that appear to have caused the failure of the supply in the first instance, the instrument should be connected to the Variac at minimum setting and switched on. The D.M.M. or Multimeter and/or the monitor oscilloscope is then connected between chassis and the various rails, starting at reservoir capacitor C401. The Variac setting is slowly advanced. If no reading or a low reading is obtained on the meter and/or if the oscilloscope indicates half-wave rather than full-wave ripple across C401, then rectifier diodes D401-404 and C401 should be examined.
- (c) Assuming that (b) is in order then the meter and oscilloscope should be connected respectively to the +22V rail and the taps of the inverter transformer (pins 9 or 10). As the Variac is advanced to approximately 25% of line voltage, the inverter should begin to function and rail voltages should appear but at reduced values. The preceding steps have served to bypass the power supply regulating loop and if there is no fault in the rest of the instrument, the Variac can be advanced to nearly full line voltage, until the +22V rail reads correctly. Correct readings should then exist on all the other rails, and the fault has been cleared or else lies within the regulator loop. If the fault has *not* been cleared, then the Y and X boards should be disconnected *one at a time*, to determine whether the fault lies in these, since removal of all loading from the power supply can cause the inverter to function erratically.
- (d) The monitor oscilloscope may also be connected across the 4-6 $\Omega$  resistor, at the terminal corresponding to the collector of the Darlington transistor (246/19). The waveform produced by a correctly functioning inverter with correctly established rails consists of a rectangular wave voltage of approximately 25 $\mu$ s period, with a mark-space ratio of the order of 5 : 1. Should this be erratic or uneven, the components around the primary and secondary of inverter transformer T402 should be examined.
- (e) When the previous step has resulted in the clearing of any power supply or Y and X board faults, the 4-6 $\Omega$  resistor should be removed and the Darlington 3 pin connector should be re-inserted. Again the instrument should be switched on progressively through the Variac and the +22V rail monitored by the Multimeter. The oscilloscope should be connected to the collector of TR402 and, if dual beam, to pins 9 or 10 of TR402, as before. Note that a certain amount of ripple will be visible together with inverter waveforms, amounting to about 4-5 volts peak to peak. this is quite normal.
- (f) If the regulating loop is functioning correctly, then all rails should be established and the same rectangular waveform should appear at TR402 collector, including mains ripple.  
Note that the most convenient place to probe this collector is at the anodes of diodes D414-415, near the inverter transistors.  
If the power supply is *not* functioning correctly when the loop is re-established, after 'external' faults have been cleared by the procedure described (a) - (c), then the faulty component *must* be associated with transistors TR401-403. The three-way socket to the Darlington transistor may also be faulty.
- (g) Finally, when all faults have been cleared, the Variac should be set at the centre voltage of the instrument setting in use and the +22V rail adjusted via R418 to within 0.1V of its rated value.

## 7.5.4 C.R.T. BLANKING CIRCUITRY

- (a) The description of the operation of the Blanking circuitry should be read and used as a guide in fault-finding this part of the circuit. A dual-beam service oscilloscope is essential for the verification of blanking and unblanking signals to terminals PL401b/10 and PL401b/5 respectively; both these are negative. The chop-blank waveform consists of a 3V  $\mu$ s signal from the Y board (PC244) the unblanking signal is a low from the time base lasting for the duration of the sweep.
- (b) If the CRT is completely blanked, when the blanking circuitry is functioning correctly, the components around the grid-cathode of the CRT should be checked, together with coupling capacitors C422 and C423.
- (c) If the CRT is not blanking and assuming that the pulses in (a) above are present, then the fault is most likely to be in the Blanking circuit and in IC401, in particular.

# SECTION 8

## RE-CALIBRATION

### 8.1 INTRODUCTION

#### 8.1.1 GENERAL

The solid state design of the instrument makes frequent adjustment of the internal preset components unnecessary. The appropriate part of the re-calibration procedure should be carried out, whenever the instrument fails to meet its specification, or whenever a defective component is replaced. Section 4 should be helpful in deciding which part of the circuit requires adjustment. It is advised that isolated adjustments are not made, because of the risk of interaction with settings made in earlier checks.

Due to the complex nature of the instrument only qualified persons should attempt the re-calibration procedure.

In order to re-calibrate the instrument it will be necessary to remove the top and bottom covers. This will expose high voltage areas, therefore care must be taken when the instrument is connected to the a.c. line source.

#### 8.1.2 CALIBRATOR

The internal 250mV calibration signal is used to check the vertical amplifier sensitivities and probe compensations.

#### 8.1.3 TOOLS AND EQUIPMENT

To carry out the whole calibration procedure, the following tools and equipment are required:—

Low capacitance trimming tool (for preset capacitors).

Small screwdriver (for preset potentiometers).

Time-mark Generator providing markers of 5ms and 5 $\mu$ s. Accuracy to be within 0.1%.

Squarewave Generator, providing outputs of 1kHz and 10kHz, 25mV to 100V.

Squarewave Generator, providing an output of 1MHz with rise time less than 2ns.

Coaxial cable and terminating resistor, for the above.

Monitor Oscilloscope complete with x1 and x10 passive probes.

Passive Probe, x10 attenuation, suitable for input capacities of 30 to 50pF.

Digital Voltmeter 2.5V d.c. to 2500V d.c.

Sinewave Generator, 1kHz, 10kHz and 50kHz.

Coaxial leads allowing the same signal to be connected to both channels of the oscilloscope.

NOTE: Input signal values are peak to peak.

### 8.2 RE-CALIBRATION PROCEDURE

#### 8.2.1

- 1) Ensure that no external leads are connected.
- 2) Remove top and bottom covers (reference Section 7).
- 3) Connect to a suitable a.c. line voltage and switch on.

#### 8.2.2 INITIAL SETTINGS

Set the controls on the front panels as follows:—

CH1-DC-GND-AC-OFF	GND
VOLTS/DIV	5mV
↕	
	mid position
CH2-DC-GND-AC	GND
VOLTS/Div	5mV
↕	
	mid position
ADD	}
-CH2	
x5 CH1	
x5 CH2	out (D1011 only)
LEVEL ± slope	mid-position in
AUTO-NORM-TV	AUTO
SECS/DIV	1ms
↔	
	mid-position
CH2-EXT-LINE	CH2
VARIABLE X-Y	fully clockwise and pushed in (D1011 only)
x5	in
FOCUS	Adjust for a well defined display of suitable intensity.
INTENSITY	

#### 8.2.3 D.C. SUPPLY LINE VOLTAGES (R418)

The d.c. line voltages should normally be within the prescribed limits when the setting of the range selection switch coincides with the a.c. line voltage.

If certain power supply components such as D405, TR401 and TR403 are replaced this is likely to affect the level of the voltage outputs and usually requires a complete re-calibration of the instrument.

1. Connect a digital voltmeter set to a suitable d.c. range, with positive to +22V, available at junction R416/ D405 and negative to chassis.
2. Adjust R418 for a meter reading of +22.0V ( $\pm 0.1V$ ).
3. The remaining supply line voltages should be within the limits shown in the table, although these need not be checked unless a fault is suspected.

Supply Line	Limits
- 22V	- 22.2V to - 22.5V
+ 175V	+ 170V to + 180V
- 1700V	- 1650V to - 1750V

These voltages must be maintained over the full range of a.c. line voltages according to the specification.

#### 8.2.4 CRT CONTROLS

1. Apply 0.1ms markers to CH2 input and switch CH2 to DC coupling.
2. Adjust CH2 VOLTS/DIV to obtain approximately 1 to 2 divs of display.
3. Adjust FOCUS and ASTIG (rear panel) to obtain an optimum trace thickness.
4. Remove marker signal.
5. Position the trace centrally on the screen.
6. Adjust the TRACE ROTATION to align the trace with the horizontal graticule lines. (Note that if the CRT has been changed, it may be necessary to reverse the trace rotation coil leads from the CRT to the power supply circuit board PC246).
7. Turn INTENSITY fully clockwise and trigger source to NORM so that no sweep runs.
8. Adjust R444 on PC246 so that a spot is just visible near the centre of the CRT.
9. Set trigger source to AUTO and adjust INTENSITY for normal brightness of display.

#### 8.2.5 VERTICAL AMPLIFIER

All adjustments and references apply to PC244 except where otherwise stated.

##### 8.2.5.1 CH1 AND CH2 GAIN & VOLTS/DIV BALANCE

1. Set CH1 and CH2 VOLTS/DIV to 50mV.
2. Set CH1 and CH2 DC-GND-AC to DC.
3. Set SECS/DIV to 5ms.
4. Apply 250mV 1kHz squarewave to signal to CH2 INPUT.
5. Connect an a.c. coupled x10 probe with the monitor oscilloscope to R730 (trigger output) and adjust R715 to obtain a 200mV peak to peak squarewave on the monitor scope.
6. Remove the probe from R730 and adjust R745 for 5 divs display.
7. Apply a 250mV 1kHz squarewave to CH1 INPUT.
8. Connect the monitor scope via the x10 probe to R633 and adjust R615 for 200mV peak to peak on the monitor scope.
8. Remove the probe from R633.
10. Connect a 250mV 1kHz squarewave to CH1 and CH2 inputs.
11. Reduce CH2 sensitivity to 200mV/div.
12. Adjust R645 for 5 divs display on CH1.
13. Remove the signal from both inputs.
14. Set both DC-GND-AC switches to GND.
15. Adjust R714 for no vertical trace movement when CH2 VOLTS/DIV is rotated between 5, 10 and 20mV.
16. Adjust R614 for the vertical trace movement CH1 VOLTS/DIV is rotated between 5, 10 and 20mV.

##### 8.2.6 x5 GAIN BALANCE (D1011 only)

Pre-sets are mounted on daughter board PC253.

1. Adjust R613 for no trace movement when pressing CH1 x5 IN and OUT alternately.
2. Repeat for CH2 by adjusting R713.

#### 8.2.7 VERTICAL AMPLIFIER INPUT COMPENSATION

1. Set CH2 DC-AC-GND to DC and VOLTS/DIV to 5mV.
2. Apply 25mV 1kHz squarewave to CH2 INPUT.
3. Adjust C961 for a square corner.
4. Set SECS/DIV to 0.2ms.
5. Increase signal amplitude to 250mV and VOLTS/DIV to 50mV.
6. With C955 set to mid-position to minimise interaction, adjust C954 for a square corner.
7. Increase signal amplitude to 2.5V and VOLTS/DIV to 0.5V.
8. Adjust C955 and C957 for a square corner.
9. Repeat steps 5 and 6. If it is necessary to re-adjust C955 re-check steps 7 and 8.

10. Switch CH2 DC-AC-GND to GND and remove the signal from CH2 INPUT.
11. Apply 1kHz trigger signal to EXT TRIG socket and change trig source to EXT.
12. Apply 25mV 1kHz squarewave to CH1 INPUT.
13. Set CH1 DC-AC-GND-OFF to DC and VOLTS/DIV to 5mV.
14. A locked trace should now appear on the screen.
15. Adjust C911 for a square corner.
16. Increase signal amplitude to 250mV and CH1 VOLTS/DIV to 50mV.
17. With C905 set to mid-position to minimise interaction, adjust C904 for a square corner.
18. Increase the signal amplitude to 2.5V and CH1 VOLTS/DIV to 0.5V.
19. Adjust C905 and C907 for a square corner.
20. Repeat steps 16 and 17. If it is necessary to re-adjust C904 repeat steps 18 and 19.
21. Remove signal from CH1 INPUT.
22. Apply 250mV 1kHz squarewave via a x10 probe to CH1 INPUT.
23. Set CH1 VOLTS/DIV to 5mV and DC-GND-AC to DC and adjust the probe compensation for a square corner.
24. Increase signal amplitude to 2.5V and CH1 VOLTS/DIV to 50mV.
25. Adjust C902 for a square corner.
26. Set CH2 DC-AC-GND to DC.
27. Apply 250mV 1kHz squarewave to CH2 INPUT via a x10 probe and set VOLTS/DIV to 5mV.
28. Adjust probe compensation (if necessary) for a square corner.
29. Increase signal amplitude to 2.5V and VOLTS/DIV to 50mV.
30. Adjust C952 for a square corner.
31. Remove probe and trigger signal and switch trig source to CH2 (internal).

#### 8.2.8 X-Y GAIN & BALANCE (D1011 only)

The following adjustments are on PC245.

1. Apply 25mV 1kHz squarewave to CH1 INPUT with VOLTS/DIV set 5mV, and DC coupling.
2. Position the signal so that the bottom edge is 2 divisions below the graticule centre and the top edge is 3 divisions above the graticule centre.
3. Pull VARIABLE to X-Y position.
4. Adjust R124 for 5 divs of horizontal deflection.
5. Adjust R126 so that the spots are 2 divisions to the left and 3 divisions to the right of the graticule centre. (Note that because of interaction between R124 and R126 careful adjustment is necessary).

#### 8.2.9 VERTICAL AMPLIFIER HIGH FREQUENCY COMPENSATION

1. Apply 5 divs amplitude (approximately) of 1mHz fast rise squarewave via a terminated cable to CH2 INPUT.
2. Set CH2 VOLTS/DIV to 5mV and SECS/DIV to 0.2 $\mu$ s.
3. Adjust C822 and R827 (both on PC246) and C731 (PC246) for a square corner with no overshoot or ringing.
4. Remove the signal from CH2 and apply to CH1 INPUT.
5. Set CH1 VOLTS/DIV to 5mV.
6. Connect a 1MHz trigger signal to the EXT TRIG socket and switch trig source to EXT.
7. A locked trace should now appear on the screen.
8. Adjust C631 (PC244) for optimum square corner. (Note that C822 and R827 may require minor re-adjustment) and then adjust C731 for the best overall corner.
9. Note that CH2 may require re-setting if C822 and R827 are re-adjusted.
10. Remove the input signals and return trigger source to CH2 (internal).

#### 8.2.10 INTERNAL CALIBRATOR (R106)

1. Connect CAL output to CH1 INPUT.
2. Set VOLTS/DIV to 50mV and TIME/DIV to 1ms.
3. Set trigger source to EXT.
4. Adjust R106 (on PC245) to display 5 divs signal amplitude.
5. Remove CAL signal connection.

**8.2.11 SWEEP ACCURACY (R111 and C76)**

1. Apply 5ms markers to CH2 INPUT with SECS/DIV set to 5ms and adjust VOLTS/DIV for 2 to 3 vertical divisions of display.
2. Adjust R111 for 1 marker per division.
3. Change to 5 $\mu$ s markers with SECS/DIV set at 5 $\mu$ s.
4. Adjust C76 (PC245) for 1 marker per division.

**8.2.12 TRIGGER SENSITIVITY (R49)**

1. Apply a 50kHz sinewave of 60mV amplitude to CH2 INPUT, with trigger set to +ve slope, SECS/DIV to 10 $\mu$ s.
2. Check that with VOLTS/DIV set to 20mV, there is a display of 3 divisions peak to peak.
3. Set VOLTS/DIV to 0.2V (to provide a display of 3mm amplitude).
4. Via a x10 probe, connect a monitor 'scope to the anode of D17 on PC245.
5. Set monitor scope controls for 2 $\mu$ s/div sweep and 50mV/div sensitivity, internal triggering and +ve slope.
6. Using the monitor 'scope horizontal control, position the leading edge of the square waveform displayed to coincide with the extreme left hand graticule line.
7. Adjust R49 on PC245 to ensure that when the LEVEL control is rotated alternately fully clockwise and then fully anticlockwise, the falling edge of the squarewave displayed on the monitor 'scope moves an equal distance to the left and then to the right of the centre graticule line.
8. Repeat step 7 but set the trigger slope to -ve.
9. Optimise the setting of R49 by minimising errors in steps 7 and 8.

# SECTION 9

## STANDARD OPTIONS AND ACCESSORIES

### 9.1 INTRODUCTION

A Standard Option is an extra or an alternative feature usually incorporated into the standard instrument at the manufacturing stage, and marketed on the same terms as a standard instrument.

A number of accessories are available for purchase to increase the facilities of the instrument.

### 9.2 STANDARD OPTIONS

If the standard instrument has been supplied with one or more of the Standard Options listed below, the appropriate technical data must be used in conjunction with the standard manual information.

Option 4 P7 CRT (Part Number 154-0826-01) and Amber Graticule (Part Number 331-0547-03) fitted in place of P31 CRT and blue graticule.

Option 6 For operation on 115V line voltage and fitted with USA power cord (Part Number 161-0124-01)

### 9.3 ACCESSORIES

	<i>Part Number</i>
Front Protection Cover	016-0439-01
Viewing Hood	016-0647-01
Camera Adaptor for type C5B Camera	016-0646-00
Probe Type TP1 (X1, 1.5m)	010-0291-00
TP2 (X10, 1.5m)	010-0292-00
TP2 (X10, 1.8m)	010-0292-02
TP2 (X10, 3.0m)	010-0292-03
TP3 (X100, 1.5m)	010-0293-00
TP4 (Detector, 1.5m)	010-0294-00
TP5 (X1/X10 Switchable 1.2m)	010-0295-00
TP5 (X1/X10 Switchable 3m)	010-0295-01
Replaceable Probe Tip	015-0328-00

### 9.4 RACK MOUNTING D1010R and D1011R

Front-entry rack-mounting versions of the standard instruments are available as D1010R and D1011R. A supplement to this standard manual is supplied, (Part Number 070-2903-00).